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IONDS AND GOLD
IN SOUTH AFRICA.

THEODORE REUNERT.

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IN

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BY

THEODORE REUNERT,

M. Inst. M.E.; Assoc. M. Inst. C.E.

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To the Memory

OF

MY FATHER.

PREFACE.

SOME of the following pages have already appeared in print. The section on the diamond fields, originally written for the 'Official Handbook of the Cape of Good Hope,' was issued in pamphlet form at the time of the Kimberley Exhibition of 1892, on which occasion also the paper on the gold fields was delivered as a lecture. It is now published for the first time, and the whole work has been carefully revised and brought up to date, besides being considerably enlarged by the addition of the latest statistics bearing on the two industries, and by a number of articles on points of special interest, which will be found in the Appendix. I take this opportunity of acknowledging my indebtedness, not only to the gentlemen whose names are affixed to these articles, but also to the managers and secretaries of Companies who have freely placed much valuable information at my disposal; to many old colonists for useful comments and criticism; and, especially, to Mr. John Noble, of Capetown, for a large amount of generous assistance and encouragement. For the rest, I have drawn up a list of the principal authors consulted, to which must be added a whole library of blue-books, and companies' reports, and files of colonial newspapers, too numerous to specify.

Though the materials are at hand for doing justice to the subject, yet, in spite of the number of works that have been written on South Africa, it cannot be said that the diamond and gold fields, which form the backbone of the country, have received that attention at the hands of either scientific or imaginative writers which they deserve. To the geologist, the metallurgist, and the mining engineer, they offer a mass of interesting facts and problems, of which the outside world is still profoundly ignorant; while the romantic incidents connected with their discovery and early development afford ample materials for the historian, the poet, and the novelist. This book aims merely at giving an outline of the rise and progress of the leading industries of South Africa, in a popular form suited to the general reader. A residence of fourteen years in Kimberley and Johannesburg has placed the writer in a position to describe, it is hoped with some degree of accuracy, the conditions under which these important industries sprung into life, and the systematic manner in which they are now being conducted.

Africa is proverbially the land of surprises, but it is difficult to imagine that any more startling surprises can be in store for us than have been witnessed within the generation in which our lot has been cast. Some day the history of this generation of discoveries will be written by a historian worthy of the task, and he will make of it a story more wonderful than any fairy tale. He will tell of a land apparently destitute of resources, barely able to support its scanty population living the most frugal lives, suddenly transformed, "as from the stroke of the enchanter's wand," into a perfect Sindbad's cave of precious stones and gold. Scarcely a quarter of a century has passed since the discovery of diamonds in Griqualand West converted a corner of the desert into a teeming hive of industry, shut out by barren wastes from communication with the sea and the fertile districts of the country; and now the huge continent is vibrating with the tread of the iron horse, that is breaking down old boundaries and preparing the way for a confederation, which, when the day of its fulfilment arrives, will at once take rank among the leading states of the world.

What a future there is before us in South Africa!—a vast country waking up, as it were, from the sleep of ages, and realising all at once that it is destined to play a great part in the world. A superb climate, a fertile soil, boundless mineral wealth, and, all around, millions of idle hands waiting to be employed in its extraction. When we think of the melancholy state of society in the Old World, and in the New; of the bitter struggle for existence; of the overcrowded cities, with their awful poverty, and vice, and wretchedness; of the hard unlovely lives of the many, in contrast with the ease and luxury of the favoured few; of the impending death-struggle of capital and of labour, and that other menace, which hangs like a nightmare over Europe, of immense armaments ready at any moment to spread desolation and mourning over the land;—we have reason to thank God that we live in a land as yet free from the worst heritages of civilisation, a land of such infinite promise that the boldest may turn pale and tremble with excitement when they contemplate the scope it offers to every noble ambition—a land that answers better than any other in the world to that magnificent description in the Book of Job:—

> "The stones thereof are the place of sapphires,
> And it hath dust of gold."

T. R.

JOHANNESBURG,
May, 1893.

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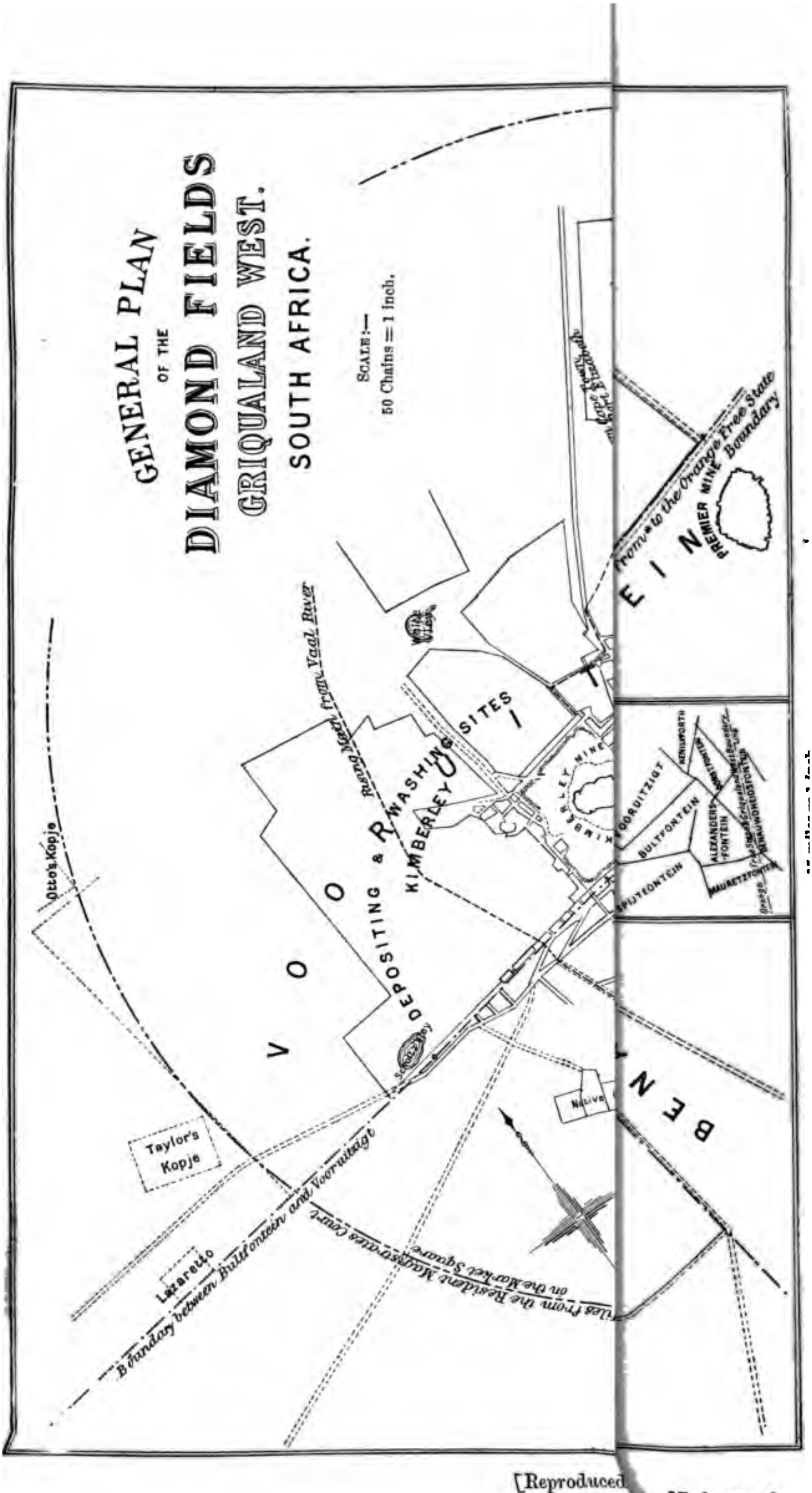
PART I.

THE SOUTH AFRICAN DIAMOND FIELDS.

428½ Carats.



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THE DIAMOND FIELDS.

During the four centuries which have elapsed since the Portuguese sailors, steering south in search of the sea route to India, first sighted the Cape of Good Hope, it may safely be asserted that no more important event has happened in South Africa than the discovery of the first diamond by Mr. John O'Reilly, in the month of March, 1867. The beneficial effects of that discovery are apparent to-day in every corner of South Africa. It has spread new life and energy through all the Colonies and States, which five-and-twenty years ago were in a languishing and impoverished condition; and has converted the most despised possessions of Britain into sources of revenue to the mother country, and fields of ever widening enterprise for her sons.

A full review of the results which have followed the discovery of diamonds would entail writing a great part of the history of South Africa during the past quarter of a century; but among the most evident of these results are, the increase of trade and industry, the greater employment of native labour, the progress of public works, the general dissemination of wealth throughout all classes of the community, and last, but not least, the steady advance of civilisation into hitherto unexplored regions.

Before the diamond mines were discovered, the wealth of the country was derived almost exclusively from its sheep and cattle: the total *exports* of the Cape Colony amounted to little more than two millions sterling per annum, more than three-quarters of which consisted of exports of *wool*. To-day the exports from South Africa are seven-fold that sum, to which *diamonds* and *gold* contribute more than half.* Until quite recently the value of diamonds exported was far in excess of any other article we produced. For the last ten years they have formed on an average half the gross exports of the Cape Colony, but are now exceeded by our gold exports. In the year 1890 the value of gold exported from South Africa was under two millions sterling, while the exports of diamonds were considerably over four millions, and the exports of *wool* nearly three millions; but the steadily increasing output of Witwatersrand has brought the production of gold up to nearly five millions per annum, so that gold and diamonds together now form over *sixty per cent.* of the total exports from South Africa.

During the period under review, the rapid development of mining industries, and the consequent influx of money and population, have increased the value of goods *imported* in almost equal ratio to the exports. In the year 1892, the imports through the four chief ports of South Africa (Capetown, Port Elizabeth, East London, and Durban) amounted to nearly thirteen millions sterling.

The effect of the discovery of diamonds on the *natives* is too important to be left without a word of comment. In many other countries where European enterprise has brought to light the hidden riches of the earth, the manual labour at the mines is performed entirely by white men, before whom the aborigines have gradually vanished off the scene. But the strange persistence of the South African native in declining to disappear, but, on the contrary, increasing and multiplying, in face of the European, might have been a most serious obstacle to colonisation. Luckily, however, our native races have proved themselves admirably adapted to handling the pick and shovel. They have been taught to work, instead of fight; and since the large demand for labour at Kimberley, the constantly recurring native wars have ceased to be a burden and menace to the country.

The need of easy and quick *communication* between the coast and the Diamond Fields has caused roads, railways, and telegraphs to be constructed on a much larger scale than would otherwise have been contemplated; thus affording further employment for natives. Meanwhile, the increase of trade has justified extensive improvements to our harbours, and has secured us a weekly service of fast ocean steamers, and two independent lines of cable to Europe. The journey from London to Kimberley can now be accomplished, taking passage to Table Bay by the fast steamers of the Union and Castle Mail Companies, in seventeen days; about half the time it required to reach the Diamond Fields from Capetown, only twenty years ago.

---

* Appendix I.—Value of South African Exports, p. 125.

Of the *sixty or seventy millions sterling* realised from diamonds found at Kimberley during the last twenty years,* probably one-half has been paid away in wages at the mines, and for other local expenses. A large amount has gone into the pockets of farmers and transport-riders; considerable sums to colonial merchants, and to the Government and landed proprietors for rates and licences. The profits, until quite recently, have been chiefly earned by private diggers and shareholders resident in South Africa; so that all sections of the population have been enriched, directly or indirectly, by the produce of the mines.

But for the discovery of diamonds, the countries north of the Orange River would probably still have remained in almost undisturbed possession of the native, with a sprinkling of Boer farmers, traversed occasionally by a stray trader or hunter, whose accounts of reputed mineral wealth, and of rich pastoral and agricultural lands, would have continued to be received with smiling incredulity. Even after the Northern Gold Fields had been discovered, twenty years passed with only a feeble and unsuccessful attempt at exploration; and it was reserved for the energy and capital of Kimberley men to develop the wealth of the Transvaal, and to penetrate the Dark Continent north of the Limpopo.

It was three or four years after the finding of Mr. O'Reilly's first diamond before the true mines of Kimberley were discovered. The history of Mr. O'Reilly's discovery is too well known to need a detailed repetition. In March, 1867, he was returning from a hunting trip across the Vaal River; and resting for the night at Schalk van Niekerk's farm, "De Kalk," in the Hopetown district, south of the Orange River, he noticed a beautiful lot of river pebbles on the table, out of which he picked the "first diamond." Neither the hunter, nor the farmer, was aware of its value. Arriving at Colesberg, Mr. O'Reilly showed it to the Acting Civil Commissioner, Mr. Lorenzo Boyes, who, finding that it *cut glass*, thought it must be a valuable stone, and asked O'Reilly to let him send it to Dr. Atherstone, at Grahamstown. Several Jews at Hopetown and Colesberg had pronounced it to be a topaz, and worth nothing. Dr. Atherstone replied, "I congratulate you on the stone you have sent me. It is a veritable diamond, weighs 21¼ carats, and is worth £500. It has spoiled all the jewellers' files in Grahamstown; and where that came from there must be lots more." Dr. Atherstone's opinion was confirmed by M. Herriette, the French Consul in Capetown, where the stone was purchased at these gentlemen's valuation by the Governor, Sir Philip Wodehouse, and sent to the Paris Exhibition of 1867.

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* Appendix II.—Value of Diamonds exported, p. 126.

Mr. Boyes at once got leave of absence from the Government and set off for Van Niekerk's farm, where he spent a fortnight examining sacks of bright pebbles, but found nothing like a diamond among them. Some six months later, however, another diamond was found, but this time below the junction of the Orange and Vaal Rivers. Mr. Boyes again procured leave and proceeded to the scene of the discovery, but could find no trace of diamonds, and came to the conclusion that this one had been brought to the spot where it was found by the overflowing of the Vaal River. By this time the attention of every one in that neighbourhood was turned to seeking *blink klippe* (bright eyes), and during the following year several diamonds were picked up on the banks of the Vaal by the Koranas, a lazy dirty tribe allied to the Hottentot race.

Still, the existence of diamond-fields in South Africa continued to be doubted, and absurd theories were started to account for the few discoveries that had been made. Mr. J. R. Gregory, a professed expert, who came out from England to inspect and report upon the country about Hopetown, declared that the diamonds found there must have been carried by ostriches from some far distant region of the

BARKLY WEST, VAAL RIVER DIGGINGS.

[*To face page* 7.

interior.* But unfortunately for this gentleman's reputation, the evidence soon became overwhelming that diamonds in quantities existed along the northern bank of the Vaal, and, to crown all, in March, 1869, the now famous "Star of South Africa" was obtained from a native witch-finder, who had been in possession of it for a long time without the least idea of its value other than as a powerful charm.† This magnificent brilliant was a pure white diamond of 83½ carats when uncut, and was sold to Messrs. Lilienfeld Brothers of Hopetown for £11,000, and subsequently purchased for the Countess of Dudley for £25,000.

When it was clearly authenticated that a gem of such value had been found, the first great rush of diggers made their way up to the Vaal, fully equipped with mining implements, and prepared to take the place of the previous native searchers who had been merely scratching the surface. First to commence work was a party from Natal,‡ who, after some unsuccessful prospecting on the Free State side of the river, crossed over and formed the first mining camp near the mission-station at Hebron. Many other diggings were soon opened lower down the river, but still on the northern bank, the largest of these being at Klipdrift, now known as Barkly West. Early in 1870, diamonds were found on the southern bank, near the mission-station of Pniel, opposite Klipdrift, and later in the same year news came of diamonds having been discovered twenty miles further south. "Some children of a farmer named Van Wyk, residing at Dorstfontein, on the rim of a saucer-like depression of the ground known as Dutoitspan, had picked several small diamonds from the mud with which their dwelling was plastered. Forthwith search was made in the place from which the mud had been taken, and diamonds were found. A party of diggers hastened to Dutoitspan, and found several farmers, friends of the proprietor, already at work. They asked permission to dig, and offered to pay a reasonable fee to the owner of the ground, but were ordered away. The farmer did not want them there. But, as they would not leave, he was obliged to come to terms, and the dry diggings—as they were called—were opened at Dorstfontein."* This was the origin of Dutoitspan Mine. The Bultfontein Mine, situated a few hundred yards away, was discovered a few months later, and was followed, early in 1871, by the discovery of De Beers Mine, and in June of the same year by the discovery of Kimberley Mine. The Jagersfontein Mine, in the Free State, eighty miles south-east of Kimberley, was discovered about the same time.

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* "In the 'Geological Magazine' of December, 1868, appears an article on this subject, by J. R. Gregory, declaring the whole story of the Cape diamond discovery to be 'false,' 'an imposture,' 'a bubble scheme,' got up to promote the expenditure of capital in searching for this precious substance in the colony; and stating that, from the geological character of the district which he had lately very carefully and thoroughly examined, it was *impossible* that diamonds had been or could ever be found there." In his reply to Mr. Gregory, Dr. Atherstone delivered himself of the following opinion, which deserves to be preserved as an instance of a remarkably just prediction, based on careful scientific reasoning:—"Sufficient has been already discovered to justify a thorough and extensive geological research into this most interesting country; and I think for the interest of science, and the benefit of this colony, a scientific examination of the country will be undertaken. So far from the geological character of the country making it *impossible*, I maintain that it renders it probable, that *very* extensive and rich diamond deposits will be discovered on proper investigation. This I trust the Home Government will authorise, as our colonial exchequer is too poor to admit of it." See a most interesting letter from Dr. W. Guybon Atherstone, M.D., F.G.S., in the above magazine for May, 1869, refuting Mr. Gregory's statements.

† 'Theal,' p. 329.

‡ For an interesting account of this first expedition by the promoter, Major Francis, of H.M. 20th Regiment, see the memorial presented by him to Sir Henry Barkly, in 1870, printed in Capetown, but not published. The exploring party consisted of W. C. King, T. T. Gline, W. Boyse, W. Valentine, H. Becher, and T. Rolleston.

The region of these startling discoveries, which were destined to open a new chapter in South African history, had been regarded for ages as a sort of No-Man's Land, too valueless to need a rigid definition of ownership. When its mineral wealth was suddenly revealed, rival claims to the country naturally arose, which were not definitely settled till the London Convention of July, 1876, when the Free State accepted a monetary compensation in settlement of its claims, and Griqualand West remained a Crown Colony till October, 1880, when it was formally incorporated in the Cape Colony.†

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* 'Theal,' p. 334.

† Appendix III.—Early History of the Diamond Fields, p. 127.

What may be called the diamondiferous area is embraced on the north, west, and south between the wide fork formed by the junction of the Vaal and Orange Rivers, the two principal rivers of South Africa.* Although the first diamonds were found a few miles south of the Orange River, and alluvial diggings are still being worked on the northern bank of the Vaal, there is no evidence for believing payable deposits of diamonds to exist northwards of the Vaal or south of the Orange River. All the important diamond mines and diggings are contained within the square formed by the 28th and 30th parallels, and the 24th and 26th degrees of longitude. The town of Kimberley is situated in about the centre of this square, and the boundary-line of Griqualand West and the Orange Free State forms almost a diagonal across the square from north-east to south-west. It will thus be seen that the Kimberley Mines are practically in the centre of the diamondiferous area, and from these *four mines* more than *ninety per cent.* of all the diamonds exported from South Africa have been raised.

The *River Diggings* extend from Delport's Hope, at the junction of the Vaal and Hart Rivers, to above Hebron, on the former stream, a distance of some fifty miles across country, or about seventy miles following the windings of the river, in the immediate vicinity of which all the diggings are situated.

There are no alluvial diggings in the *Orange Free State,* but there are several true mines, of which Jagersfontein is the most important, and to which reference will subsequently be made. They are comparatively insignificant, in view of the great wealth of the Kimberley mines, their total production forming not more than *six or seven per cent.* of the annual exports of diamonds from South Africa.

It is evident, therefore, that the diamondiferous wealth of the country lies almost entirely within the territory of the Cape Colony, and after five-and-twenty years of vigorous prospecting, it may be said to be all but confined within sight of the town of Kimberley.

The Kimberley Mines are situated on estates belonging partly to the Government, and partly to the London and South African Exploration Company.

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* See map at end of volume.

The Plan facing page 3 affords a general view of the Diamond Fields, showing the relative positions of the four mines of Kimberley, De Beers, Bultfontein and Dutoitspan; also of the two townships of Kimberley and Beaconsfield; as well as the large areas set apart for mining purposes; and the boundary-lines of the farms on which the mines are situated. The Kimberley and De Beers Mines are on the Government estate of Vooruitzigt; the Dutoitspan Mine is on the farm Dorstfontein; and the Bultfontein Mine on the farm of Bultfontein; the two latter farms, as well as the adjoining farm of Alexandersfontein, being the property of the London and South African Exploration Company, Limited. The farm of Kenilworth, lying between Vooruitzigt and Dorstfontein, has been purchased by the De Beers Consolidated Mines. All five farms lie just within the territory of Griqualand West, the boundary-line of the Orange Free State passing through the adjoining farm of Benauwdheidsfontein (lately the property of Mr. Wessels), on which the newly-discovered Wesselton, or "Premier," Mine is situated.

The boundary-line of the Vooruitzigt and Bultfontein estates passes through the centre of the town of Kimberley, while the township of Beaconsfield is unequally divided between Bultfontein and Dorstfontein, lying chiefly on the former estate. The local affairs of the two townships are administered by separate municipalities.

It will thus be seen that the greater portion of the Diamond Fields, including two of the mines, half of Kimberley town, and the whole of Beaconsfield, falls within the territory owned by the London and South African Company. The revenue of this Company during 1892, amounted to £35,114 derived from surface rentals, and £57,510 derived from mineral rights, or a total revenue for last year of £92,624, against an expenditure in South Africa of £15,040. The manager in Kimberley is Mr. J. B. Currey.

The locality of the Diamond Fields would hardly be chosen as a desirable residence by any one not in search of diamonds, or unconnected with the industry. The region may almost be described as a desert, destitute of trees or foliage, a wide expanse of rolling plains, unrelieved by any eminence worthy of the name of hill; without rivers, or water in any shape, always excepting the Vaal, which is fourteen miles from Kimberley. Owing to the altitude (4042 feet above the sea), and the absence of vegetation, the climate is extremely dry, and though heavy rains fall in the summer, six or eight months sometimes pass without a single shower, so that dust-storms are of frequent occurrence, and the verdure of the veldt is painted an undistinguishable brown. From September to March the heat is excessive, often 100° in the shade, though on account of the dryness of the air, this temperature is much less trying than it would be at the coast, and the nights, even in midsummer, are invariably cool and pleasant, in spite of the mosquitos, which have only visited the fields since the advent of the railway. The winter climate is delicious, mild bright days and frosty nights, with very rarely a fall of snow. When every deduction is made, the wide open country, and the vast blue sky, have a charm of their own which grows upon one. Notwithstanding the drawbacks mentioned, the climate is far from unhealthy, and for those able to provide themselves with the ordinary comforts of life the once deadly camp-fever has lost its terrors.

The town of Kimberley [*] still bears marks of the old diggers' encampment out of which it has grown. The early diggers, who still speak of it as "the Camp," lived in tents; and when they migrated into nobler edifices of galvanized iron, the streets were not laid out with much regard to regularity. Indeed, the tin houses were frequently moved from one spot to another, and it is still no unusual sight to see a house being carted down the street, or carried, walls and roof intact, by a gang of natives. During the last ten years, however, comfortable brick houses have been built, furnished with every modern luxury; and since the Vaal River water has been brought into the town,[†] gardens have been laid out, trees and orchards have been planted; so that many portions of the town and suburbs present a very bright and pleasing appearance to travellers arriving from the monotonous journey through the arid Karoo. There are no imposing public buildings in Kimberley, but many visitors have carried away a pleasant impression of the Kimberley Club and the Public Library, which are quite equal to any similar institution in South Africa. The population in 1891 was 28,718 persons.

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[*] S. lat. 28 deg. 42 min. 54 sec., E. long. 24 deg. 50 min. 15 sec.

[†] Appendix IV.—The Kimberley Water-Works, p. 129.

The township of Beaconsfield is situated two miles to the south-west of Kimberley, with which it is connected by a tramway, and by the main line of railway from Capetown. The population numbers 10,478 persons.

A glance at Juta's map of South Africa will suffice to show that the railways of the Cape Colony are nearly all designed to serve the Diamond Fields; and where the primary object has not been to provide communication between Kimberley and the coast, the increased prosperity consequent on the opening of the mines has justified the expenditure, by which other industries have benefited. In the year 1871, when Kimberley Mine was discovered, the railway only extended as far as Wellington, a distance of 45 miles from Capetown, and neither the Port Elizabeth nor the East London line had been commenced. There are now 1700 miles of railway open and working in the Cape Colony, and northern extensions have been made, and are still being pushed forward, from Kimberley through Bechuanaland, and from Colesberg through the Free State and the Transvaal, while additional branch and junction lines are in contemplation. The natural rivalry of the three chief seaports compelled Parliament to sanction the simultaneous construction of three, or even four, main lines of railway towards Kimberley, which considerably retarded the northern advance of the locomotive. The Port Elizabeth and Graaff-Reinet line was opened on the 20th August, 1879, after which the latter town remained for some time the chief forwarding station for the Diamond Fields. In the following year, the Capetown line was opened to Beaufort West on the 5th February, the Midland line to Cookhouse on the 2nd March, and the Eastern line to Queenstown on the 5th May. The question of suitable junctions for the several systems long agitated the country, and it was finally decided to connect the Midland and Western systems between Naauwpoort and De Aar, where the opening took place on the 31st March, 1884, thus placing Capetown and Port Elizabeth for the first time in communication by rail, though only by travelling a distance of 839 miles.* This junction left the Graaff-Reinet and Queenstown lines out of the running, as far as the Diamond Fields trade was concerned. The former line has not been extended beyond the terminus it had reached fourteen years ago; but the East London line has been completed to the Orange River, and two important junctions have been constructed—the one from Molteno to Middleburg Road, on the Midland system, the other from Burghersdorp, *viâ* Bethulie, over the Orange River to join the Colesberg-Bloemfontein line. The former of these junctions is of the greatest value to Kimberley, since it connects the diamond mines with the coal fields of the Stormberg, and later, no doubt, will be extended to the Indwe. The line from Burghersdorp into the Free State will facilitate the transport of grain to the Kimberley market, and may eventually form part of the shortest route from Kimberley to East London, as an agitation is now on foot to secure a direct line from Kimberley to Bloemfontein.† The De Aar Extension was opened at Kimberley on the 28th November, 1885, in the presence of Sir Hercules Robinson, the High Commissioner, and of a large gathering from all parts of South Africa.

The distance from Kimberley to Capetown is 647¼ miles, and a daily service of trains conveys passengers to the coast in 36 hours, or once a week by the English mail in 31 hours. The distance to Port Elizabeth is 485⅓ miles, and the journey is performed in 27 hours. The up-country trip occupies 32 hours by the weekly express, or by the daily train 36 hours from Capetown, and 31 hours from Port Elizabeth. Considering that the permanent way consists of only 60 lb. steel rails for a portion of the route, with inferior metals on considerable sections; that the gauge is only 3 ft. 6 in., and that the entire railway is a single line with many heavy gradients, this must be regarded as very creditable travelling. The ordinary fares from Capetown are £8 1*s.* 9*d.*, £5 7*s.* 10*d.*

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* The distance by sea is only 428 miles.

† See map at end of volume.

and £2 13*s.* 11*d.*, for first, second, and third class; and from Port Elizabeth, £6 1*s.* 3*d.*, £4 0*s.* 10*d.*, and £2 0*s.* 5*d.*, with return-tickets at the rate of a fare and half.

Passengers for the Diamond Fields invariably disembark at Capetown, but as the goods rates are in proportion to the mileage, and the steamer freights are the same to Capetown or Port Elizabeth, all heavy merchandise goes *viâ* the latter port. The English mail trains carry only first-class passengers, and are provided with sleeping and dining cars, fitted with every convenience, for which no extra charge is made. The ordinary journey from London to Kimberley, *viâ* Capetown, a distance of 6700 miles, is completed in less than three weeks; while goods *viâ* Port Elizabeth, can be delivered in Kimberley within five weeks of leaving London. That is about the average time formerly occupied in transport by bullock-wagon from the coast to Kimberley, the cost of which varied according to the season, from £15 to £30 per ton of 2000 lbs. The railway rates for goods from Port Elizabeth are from £6 to £8 per ton; so that some idea may be formed of the saving in time and money which the railway has secured for the Diamond Fields.*

The influence of the railway on the fuel supply of Kimberley deserves a word in passing. Until nine or ten years ago, the only fuel available was native timber, and it is estimated that considerably over a million large trees have been cut down to supply the Kimberley wood market. The whole country within a radius of a hundred miles has been denuded of timber, with the most injurious effects on the climate. With the near approach of the railway, Welsh steam coal began to be imported, and was long almost exclusively used at the mines. It costs £8 to £9 per ton of 2000 lbs. delivered at Kimberley. While timber was the only fuel, as much as £30 has been paid for a wagon-load, and though, owing to the reduced demand, it is occasionally cheaper than coal, it would be precarious for the Kimberley fuel market to depend on wood alone. Nothing perhaps illustrates the great wealth of the diamond mines more strikingly than the enormous prices that have been paid for fuel during the past seventeen or eighteen years. Within the last year or two, the extension of the railway into Bechuanaland has enabled wood to be brought into Kimberley at about half the cost of English coal.

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* It is gratifying to know that this has not been accomplished at any sacrifice of the public money. The report of the general manager of railways for the year 1889, shows that the surplus of revenue over expenditure in that year was £822,128; of which £781,910 is credited to the Western and Midland expenses, which specially serve the Diamond Fields and the Gold Fields. This handsome profit is equal to 7 per cent. on the capital expended on the lines, including rolling stock.

Kimberley is not so fortunate as Johannesburg in having coal on the spot. The nearest coal mines are in the Stormberg, 300 or 400 miles away; and yet it is surprising that so many years have been allowed to elapse before placing Kimberley in direct rail communication with the colonial coal-fields. Local rivalries have been the chief cause of this delay. The junction-line from Molteno to Middleburg Road, which was opened in March, 1892, is only 87 miles long, and the distance from the Cyphergat colliery to Kimberley 335 miles. From Cyphergat to the Indwe is another 75 miles; but the latter line, though sanctioned by Parliament, has not yet been commenced.

Up to the present very little colonial coal has been used in Kimberley, but considerable quantities have been burnt on the Eastern Railway, and the relative values of the coals are therefore known. It is found that 100 lbs. of Welsh steam coal are equal to about 140 lbs. of Indwe coal, and to about 180 lbs. of Cyphergat coal. This fact alone would justify the construction of the extra 75 miles of railway to bring the superior coal into the Kimberley market, and to place it at the disposal of the colonial railways. But while the Cyphergat and other Stormberg mines are narrow seams, expensive to work and limited in output, the Indwe mines are thick seams that can be worked at about a third of the cost, and with the certainty of being able to supply all the markets within their reach.

Two circumstances, however, have interfered with the construction of the Indwe railway. First, the reported discovery of a western extension of the Indwe seams in the Sterkstroom district close to the main line of the Eastern system; and, secondly, the possible competition of the Free

State coal mines, which may be tapped by the railway from Bloemfontein to the Vaal River.

The borings in the Sterkstroom district have so far been without result; and, as regards the Free State mines, trials of the coal have not yet been conducted on a sufficiently large scale to determine its relative value. In any case this coal could not be brought into Kimberley without constructing a railway to Bloemfontein.

Whatever the ultimate decision may be, it is certain that in the near future Kimberley will be supplied with African coal at prices equivalent to little more than half what has hitherto been paid for the imported fuel.

To understand the geology of the Diamond Fields, it will be necessary to refer briefly to the order in which the same rocks occur in other parts of South Africa. The coarse grit, of which Table Mountain, and the various mountain ranges in the neighbourhood of Capetown are formed, rests unconformably on a base of clay slates (with intrusive granite) of the Silurian period, known in the South as the *Malmesbury Beds,* and reappearing in the *Lydenburg Beds* of the Transvaal. Above the *Table Mountain Sandstone* is a second series of slates and sandstones containing fossils characteristic of the Devonian period. These rocks, known as the *Bokkeveldt Beds,* form the base of the Witteberg, Zwarteberg, and Zuurberg Ranges, and are followed conformably by the massive white *Quartzites* (carboniferous) of which these mountain chains are built up. Resting unconformably on the quartzites is a great belt of conglomerate running due east and west on the northern bases of the Zwarteberg and Witteberg Mountains. This is the *Dwyka Conglomerate* of Mr. Dunn, who considers it identical with the glacial conglomerates of the Orange River basin, and assumes it to be the shore line of the ancient lake which once covered the greater portion of the Cape Colony, including a large part of the Free State and Natal. By many other geologists, however (Bain, Wyley, Atherstone, and Moulle), this remarkable conglomerate is assumed to be of volcanic origin. Professor Green, while adopting Dunn's designation, prefers to leave the decision of its origin an open question.*

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* See Appendix XXXIV. for list of geological authorities consulted.

North of the Dwyka Conglomerate, and conformable with it, lie the *Ecca Beds,* a thick deposit of sandy clay, and quartzose sandstones, greatly contorted on its southern boundary, but gradually flattening out towards the north. Still journeying north, we come upon the *Upper Karoo Beds,* a vast extent of undisturbed shales and sandstones, covering the whole of the Karoo from Graaff-Reinet to Colesberg, and stretching from the Roggeveld Mountains in the west to beyond Queenstown in the east, and thence in a narrower band to near Pietermaritzburg; while a northern extension covers the central portion of the Free State as far as Bloemfontein. To the north of the Karoo Beds are the *Kimberley Shales,* or Lower Karoo Beds, containing the diamond mines of Kimberley and the Free State; and, as their second name partly indicates, they lie conformably *beneath* the shales of the Karoo proper, and unconformably above the Ecca Beds. Finally, above the Upper Karoo Beds we have the *Stormberg Beds,* extending from Queenstown to Johannesburg and Middelburg, and from near Bloemfontein across the Drakensberg. In these beds, consisting of thick bands of sandstone interlaminated with shales, occur all the *coal measures* of the Cape Colony, the Free State, Natal, and the Transvaal.

There is much difference of opinion as to the geological age of the Kimberley shales. Mr. Dunn describes the whole series of rocks, from the Dwyka Conglomerate to the Stormberg Beds, inclusive, as "Carboniferous to Triassic." Mr. Hudleston judges the Kimberley Shales or Karoo Beds to be in all probability Mesozoic, and therefore more recent even than the Permian, or latest of the primary formations. Mr. Sawyer, from fossils of Lepidodendron and Favularia, which he found near Johannesburg in the Stormberg Beds, concludes the whole series, including the diamondiferous deposits, to be carboniferous. M. Moulle agrees with Mr. Hudleston in classing the whole of the Karoo and Stormberg Beds as Triassic.

The Kimberley Shales abut on the north against the crystalline rocks of the Transvaal, separated only by a thin band of conglomerate called by Professor Green the Basement

Conglomerate of the Kimberley Shales. Both banks of the Vaal from above Potchefstroom to Barkly West, are covered by a broad sheet of volcanic rock, partly amygdaloidal, called Diabase by Mr. Dunn, and Melaphyre by M. Moulle.* A basaltic rock of more recent age, called Dolerite by Mr. Dunn, is of constant occurrence throughout the wide stretch of country covered by the Kimberley Shales, and the Karoo and Stormberg Beds—sometimes in the form of dykes and intrusive sheets cutting through and overlying the shales, &c., sometimes as intrusive masses of trap of sufficient extent to form great hill groups.—(Green). The red ferruginous soil which is so characteristic of the plains of the Karoo, the Free State, and Griqualand West, and the rounded stones and boulders which cover the slopes of all the hills or *kopjes*, are formed from the weathering of these traps. In many districts the red soil is replaced or underlaid by a deposit of lime, or calcareous tufa, supposed to have been formed by deposition from the underlying rocks.

The mining operations at Kimberley, which have reached a depth of over 1200 feet, have of course revealed the nature of the underlying strata, and corroborate the succession of the rocks enumerated above.

Beneath the *red soil*, which varies from one to five feet in depth, there is at several of the mines a deposit of tufaceous *limestone*, from five to twenty feet thick. This is particularly noticeable in Bultfontein Mine, and in the recently-discovered Wesselton Mine; but in De Beers and Kimberley Mines the red soil is followed by a sheet of much decomposed *basalt* of columnar structure, varying in thickness from twenty to ninety feet. Microscopic examinations show this rock to be similar in character to the trap dykes of the surrounding country, and to the extensive trap sheets of the Stormberg and other districts. The prevailing minerals in all are plagioclose, augite, olivine, and ilmenite. Below the basalt, or in some cases immediately below the red soil, or tufa, are the characteristic *shales* of the country from 200 to 300 feet in thickness. At Bulfontein and Dutoitspan Mines the shale has not been

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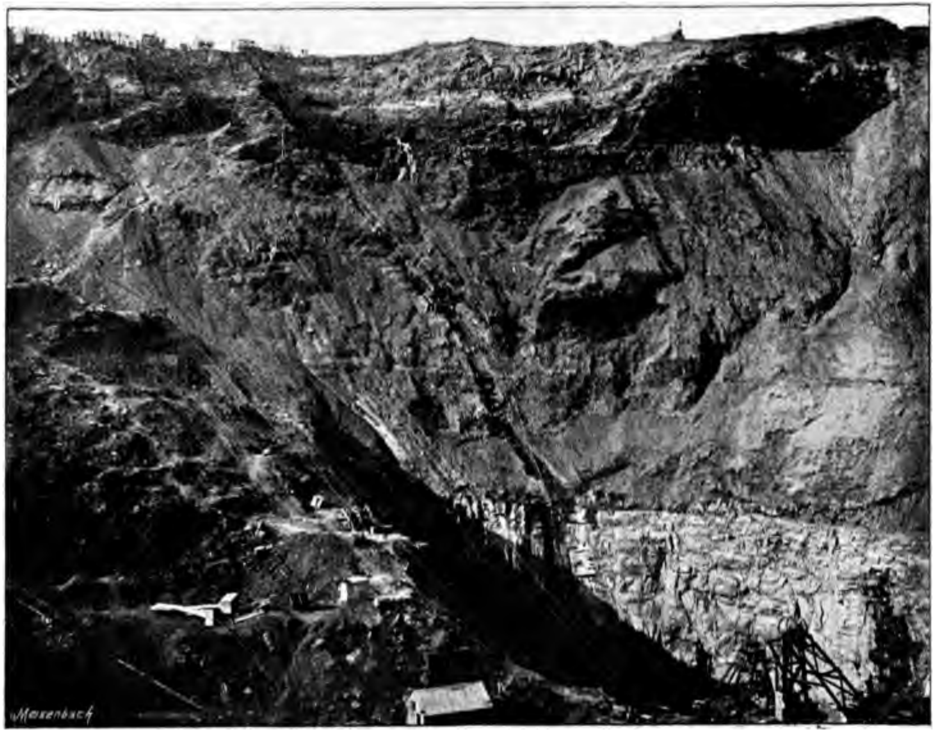
* See map at end of volume.



KIMBERLEY MINE UNDER REEF IN 1886, SHOWING CRATER-LIKE FORMATION.

[*To face page* 19.

bottomed, but it has certainly a greater thickness there than at the more northern mines of Kimberley and De Beers, while at the Vaal River Diggings it thins out altogether, thus confirming the supposition that the Kimberley Mines are situated at the northern rim of the saucer-shaped basin, which was once the great freshwater lake of the Karoo area. The shales are yellow, pink, and brown for a depth of thirty to fifty feet, changing then to black, and are almost perfectly horizontal. The black shales contain much iron pyrites and carbon, and in Kimberley, Bulfontein, and Dutoitspan Mines, have ignited spontaneously, and continued burning for years, giving off a strong sulphurous odour that can be smelt for miles. The combustion changes the colour from black to a brick-red and white. Occasional sheets and dykes of intrusive trap are met with amongst the shales. Beneath the shales is a thin bed of *conglomerate* about ten feet thick, composed of rounded pebbles and stones firmly cemented together. Mr. Dunn would identify this with the Dwyka Conglomerate, and Professor Green with the Basement Conglomerate of the Kimberley shales. Underlying the conglomerate are about 400 feet of amygdaloidal trap, or *Melaphyre*, the "Hard Rock" of the miners, identical with the "Bed Rock" of the Vaal River Diggings. It is a very hard compact rock of light olive or grey colour, with numerous nodules of agate and quartz, making it exceedingly difficult and expensive to sink through. Dr. Stelzner, of the Freiberg School of Mines, has recently determined it as "Olivine Diabase," which is virtually composed of the same minerals, plagioclose, augite, and olivine, the one being granular, the other porphyritic. Underneath the melaphyre is a similar thickness of about 400 feet of greenish *quartzite*, of hard, tough texture. In the Kimberley Rock Shaft, at a depth of 1141 feet from the surface, the quartzite changed to *Metamorphic slates*, interlaminated with thin layers of sandstone, and this is the oldest rock that has so far been pierced.*

The diamond mines are large pipes or funnels of unknown depth, and more or less oval shape, several acres in extent.

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* See Section of Kimberley Mine, facing page 54.

They are probably extinct craters which have been filled from below by volcanic mud at a time when the surrounding country was under water. In support of this theory it may be stated that the diamond-bearing rock filling the pipes contains fragments and boulders, and large floating masses, of all the encasing rocks enumerated above, as well as pieces of older and lower-lying rocks, such as granite or gneiss, which have not yet been pierced by the deepest shafts outside the mines. The softer rocks (shales) surrounding the pipes near the surface have their exposed edges turned upwards, as by a pressure from below, and the funnel itself is much more conical at the surface than in the harder rock beneath the shales. Though the mines occur in groups confined within a few square miles of country, each mine differs from its neighbour, both in the appearance and composition and physical nature of the diamond-bearing rock, as well as in the quality of the diamonds themselves; and similar strongly marked differences exist even in different parts of one and the same mine, from which it would appear that the breccia filling the pipes has been deposited by a succession of upheavals. The first mines were discovered by diamonds lying on the surface in the red sand, and subsequent search disclosed numbers more in a similar position; but no diamonds were found in the surrounding country immediately outside the margin of the mines.

The evidence of the volcanic origin of the mines may therefore be regarded as complete.

The question as to the manner in which the diamonds themselves were produced is much more difficult to solve. They have evidently not been formed in the precise positions they now occupy, since fragments of broken diamonds are frequently met with; but, on the other hand, from the distinctive character of the diamonds in different mines, we must infer that their origin cannot have been very far distant from the spots where they are actually found, though they have certainly come from a very great depth. The diamond is known to be pure carbon, and before it was ascertained that the mines extended far beneath the level of the black shales, it was conjectured that in passing through these carbonaceous shales the diamonds had been formed by chemical action due to the steam generated in the volcanic rock. It is evident now that the diamonds are of older date than the rock in which they are found, but the mode of their formation still remains a mystery.

The diamond-bearing rock has been subjected to many careful analyses. The principal minerals it contains, besides the diamonds, are bronzite, olivine, mica (biotite), garnet, iron pyrites, calcite, ilmenite, and magnetite. It is of a tough soapy texture, of a grey-blue colour, altered to yellow near the surface, where it is also much more friable. The miners distinguish between "yellow ground" and "blue ground," but the only difference is, that in the upper part of the pipe the rock has become hydrated by the action of the air, thus changing the colour from blue to yellow, and rendering the rock softer. The same change has been noticed above as occurring in the shales. In laying the results of some interesting analyses of the Kimberley rock before the Geological Society, Prof. Maskelyne states: "They will be seen to exhibit this undoubtedly once igneous rock in the light of a bronzite rock converted (except where the remains of crystals have still survived the process of metamorphism) into a hydrated magnesian silicate, which has the chemical character of a hydrated bronzite." *

The surface of the mines, in common with the surrounding country, is covered by a few feet of red sand, followed generally by a somewhat thicker deposit of lime. Underneath this the true diamond rock is reached. The yellow ground extends to a depth of 50 to 60 feet. The depth of the blue ground is unknown. It has been tested in Kimberley Mine to a depth of over 1200 feet beneath the surface, and may be regarded as practically inexhaustible, since the encasing rocks are almost vertical in the lower depths.† The surface shales and basalt surrounding the pipes are called "Reef."

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* 'Quarterly Journal of the Geological Society,' vol. xxx. p. 406, 1874.

† See Appendix V., p. 142.

It is important to remember that in diamond-mining this term is applied to the *casing* only, and not to the rocks carrying the diamonds. In the upper levels of the mines intrusive masses of shale and igneous rock are met with, called "Floating Reef." They are destitute of diamonds, and sometimes cover an area of several thousand square feet, but they disappear in the lower depths. Smaller dykes of igneous rock also occur. The ground is generally richer in diamonds in the neighbourhood of these dykes and intrusive sheets, or immediately beneath them.

The following is extracted from the valuable Technical Report by Mr. Gardner F. Williams, the general manager of De Beers Consolidated Mines:* "In the De Beers Mine there is a dyke of igneous rock extending from the south-east part of the mine around the east and the north sides, and is lost in the unexplored poor *blue* of the west end. Owing to its taking a serpentine course across the mine it has received the local name of 'Snake.' This rock has been determined (by Dr. Stelzner, Professor of Geology at the Freiberg School of Mines) to be a pikrite-porphyry, consisting of a much decomposed mass wherein little olivine crystals and mica splints are imbedded. The Snake commences at or near the surface, and extends down to the lowest workings. It does not adhere to the blue ground, but separates from it very easily. It stands like a vein, nearly vertical, varying in thickness from five to seven feet. No diamonds have been found in it.

"It is not easy to determine the nature of the blue ground, owing to the difficulty in obtaining slides for microscopical observations. After a good many trials Dr. Stelzner succeeded in getting a few sections of blue ground, which revealed the most surprising fact, to wit: 'The main body of blue ground is entirely analogous to the snake rock, naturally more decomposed, but in essential points the microscopic pictures of blue ground and snake (not taking into consideration the numerous little slate fragments in the blue) are in an extraordinary degree alike. It therefore impresses upon one's mind that the "snake" is a younger eruptive formation coming from the same volcanic source as the blue ground.'"

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* See Annual Report for 1890.

Though the blue occurs in the mines as a hard compact mass without stratification, and requiring the use of dynamite for its exploitation, there are well-defined planes separating one portion of a mine from another which generally differ in physical character and in the number and quality of the diamonds contained. These dividing planes usually dip towards the centre of the mine, and are filled with beautiful calcite crystals.

There is a great difference in the relative hardness of the blue. That in Kimberley Mine is the softest, and pulverises after a few months' exposure and treatment on the depositing floors, while some of the De Beers blue is so hard that years of exposure have no effect on it, and it has to be broken up by mechanical fine crushers before it will yield its diamonds.

When the Kimberley mines were discovered, in 1870 to 1871, and the River diggers left their healthy, but generally unprofitable, work on the banks of the Vaal, to peg out claims at Dutoitspan and Bultfontein, and subsequently at "Old De Beers" and "De Beers New Rush" (now better known as De Beers and Kimberley Mines), they naturally had no idea of the great depth of diamondiferous soil that lay under their feet. As their limited experience was confined to *alluvial* diggings, and all diamond-mining in other parts of the world, in India and Brazil, was known to be in gravel and old river-beds, they very reasonably supposed that the primitive pick and shovel would suffice to reach the bed-rock, and they laid out their works accordingly. But it must be admitted that as the excavations went down, and after the surface red-soil and lime had been removed, diamonds still continued to be found in the "yellow ground," considerable ingenuity was displayed in providing means for carrying on the mining in those then inaccessible regions, where any recognised engineering appliances were conspicuous by their absence. By a curious accident the two poorer mines were discovered first, though even De Beers was not much richer on the surface than Dutoitspan or Bultfontein. In these first mines, the claim-holders had been allowed to work very much at their own sweet will, digging out big holes here, there and everywhere, as the mines were large enough to accommodate all the workers, without fear of interfering one with another. But by the time Kimberley Mine was discovered, in July, 1871, (then called " Colesberg Kopje," after the discoverer, Mr. Rawstorne, of Colesberg, and subsequently re-named in compliment to the British Secretary for the Colonies, Lord Kimberley), sufficient experience had been gained of the probable depth of the mines to render it advisable to lay out the new mine from the commencement on a proper system. Moreover, as it was evident from the first that Kimberley Mine was so much richer than all the rest, an immense rush of diggers took place, and had to be provided for.

The new mine was thrown open on the 21st of July, 1871, a red-letter day in the annals of South Africa, since it practically inaugurated the era of profitable mining, on which the country mainly depends for its subsistence, and to which it owes its growing importance among the rising states of the world.

In the face of a good deal of opposition from the diggers, the Government (Orange Free State *) Inspector of Mines wisely decided to lay out the mine on a different plan from that adopted at the three mines previously opened. Instead of allotting the whole area within the mine to be worked as the diggers thought fit, he insisted on a reserve strip off one side of each " claim " being left unmined to form roadways. The size of a claim in Kimberley Mine is a square measuring 31 ft. by 31 ft., the mine itself forming an irregular ellipse, of which the major axis points approximately east and west. The roadways were made to run parallel with the claim-lines across the narrower width of the mine from north to south, and each roadway was 15 ft. wide, half of this width being taken alternately from the east and west of successive claims, leaving a space of 47 ft. between the several roads, so that each claim-

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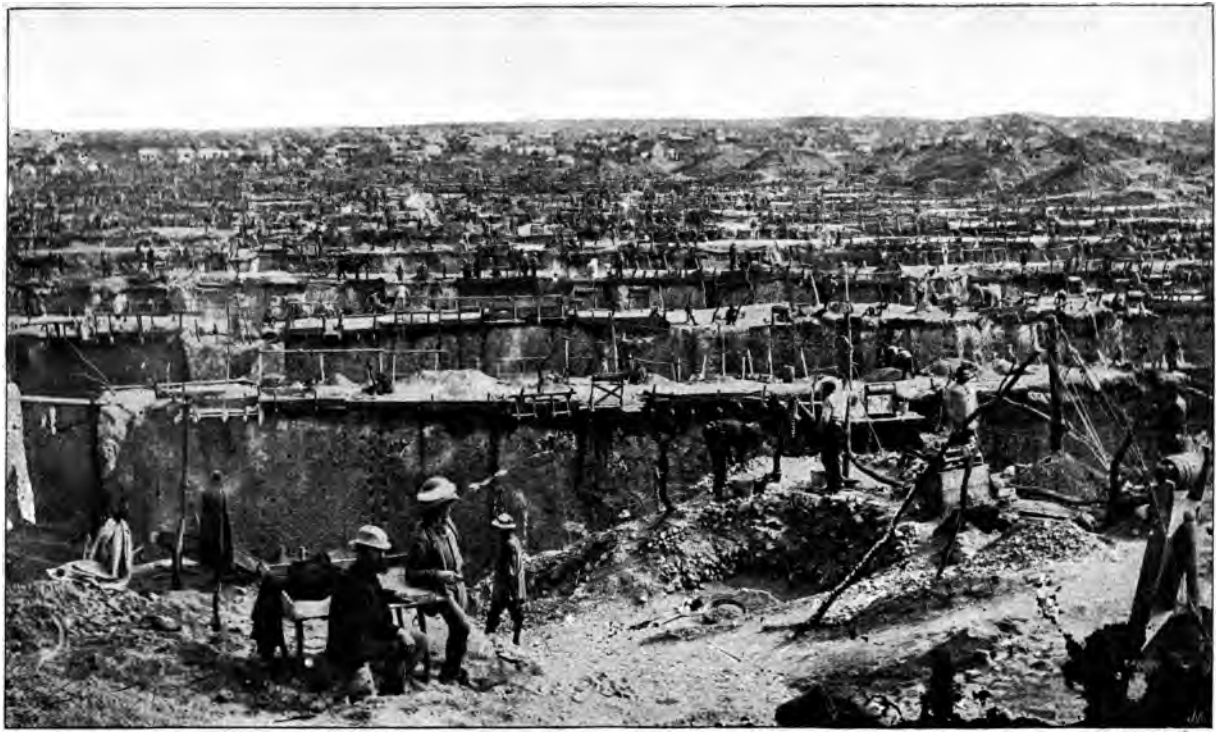
* See Appendix III.—Early History of the Diamond Fields.



THE ROADWAYS, KIMBERLEY MINE, 1872.

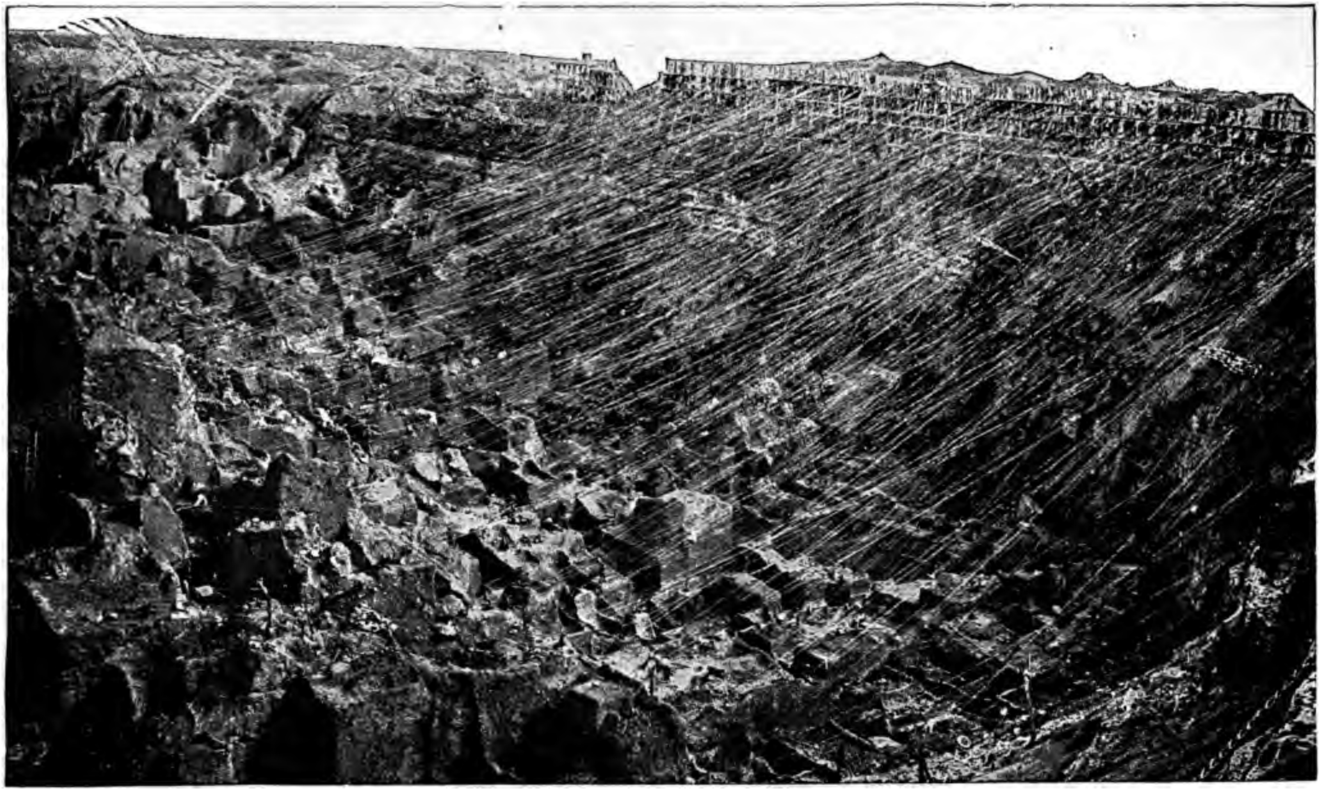
[*To face page* 25.

holder lost temporarily a strip of 7½ ft. off one side of his claim, or one quarter of his holding. This loss of ground was more than compensated for by the extra facilities for working afforded by the roadway.

Though there were only about 500 claims in the mine the precise limits of the claim-ground could naturally not be determined before the mine was opened, so that a much larger number of claims was originally allotted than the mine actually contained, even on the surface, and the claims abutting on the "reef" were soon cut out by the conical shape of the mine. But the demand for claims was so great that they were subdivided, first into halves and quarters, then down to eighths and sixteenths, the latter holding comprising no more than *five square yards,* after deducting the reserve for roadway. By law, no individual could hold more than two claims, and the "blocking" of claims was also prohibited, so that an immense number of independent claim-holders was the result, the mine being split up into no less than 1600 separate holdings. Of course this state of things could not last long, and a process of consolidation soon began, accompanied by a rapid rise in the market-value of the claims. Many diggers who had only paid the customary licence of 10s. per month for their claim, disposed of it for over £100, and the value went on increasing from month to month, as the richness of the mine became more and more apparent, till ten years later, claims changed hands at £10,000 to £15,000 each, and even at these prices they have yielded huge profits to the purchasers.

There were fourteen or fifteen roadways in all, numbered from east to west, and the names of them still survive for convenience of defining different sections of the mine, though every vestige of them has long since disappeared. Fortunately, some excellent photographs have been preserved, from one of which the illustration opposite has been taken. As early as the beginning of 1872, the roadways began to be unsafe; the working down of the claims on either side in perpendicular walls left precipitous caverns on both sides of the roads, and many were the accidents, both to the workers below, and to the carts and passengers along the roads, before the latter began to cave in. The mine was strikingly picturesque at this period of its development; hundreds of carts and wheelbarrows were to be seen careering along the hazardous narrow roads, bearing their precious freight of excavated ground clear of the mine to be sorted; while down below, at all distances from the surface, a succession of rectangular ledges represented the various working levels of different claims, where thousands of white and native labourers, crowded together on the limited working spaces, were busy picking and shovelling the ground, and filling it into the original tubs and buckets, of all sorts and sizes, employed for conveying it to the surface; some of these being hauled up by ropes and tackle, others carried by hand up inclined planks and ladders, or up staircases cut out in the perpendicular walls; each man worked on his own device, without regard to his neighbour, the only rule being that the roadways must be kept intact. Whether from design or accident, it frequently happened that masses of the high ground subsided, leaving great chasms in the roads which had to be bridged over by the owner to enable the traffic to go on; and by the middle of the year 1872, the number of these slips had increased so much that it became evident that some change in the system of working was needed; but while men were wondering what it was to be, the remaining solid portions of the roads collapsed converting the whole works into ruins. Some of the diggers were in despair, and sold out at once, thinking the mine could never recover from such a disaster. And yet it was only the first of a series of unanticipated mishaps that Kimberley mine has experienced, and that almost any less rich property would have succumbed under.

It is to be regretted that no statistics have been preserved of the number of workers employed in the mine at this period. It can hardly have been less than 10,000 or 12,000, and is estimated by many at double that number. The problem, now the roadways had collapsed, was how to work the large number of separate holdings, so as to preserve free access to each, and still let no claim-holder encroach or trespass on his neighbour's



THE KIMBERLEY MINE, WITH COBWEB OF WIRE ROPES IN 1873.

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ground. As the claims deepened, a system of rope haulage had been adopted; a couple of grooved wheels being fixed, one on the surface, the other in the claim, while to the rope passing over these wheels the bucket was attached, which was filled with ground in the claim and hauled up and down by a handle on the upper wheel. The objection to this method was, that the entire circumference of the mine did not afford frontage enough for the erection of a hauling-gear to each claim, and further, that, even had the frontage sufficed, the crossing of ropes would have been a serious difficulty.

Both these difficulties were overcome by the following ingenious arrangement. A succession of tall massive timber stagings was erected round the margin of the mine. Each staging [carried two or three platforms one above the other, every platform serving as an independent level from which to communicate with the claims below. Stationary ropes were then stretched from the different levels of the stagings to the claims, the ropes being anchored to the ground at both ends; the upper platforms communicated with the claims in the centre of the mine, the lower platforms with those nearer the margin. The hauling ropes were attached to windlasses worked by Kafirs on the several platforms, on which grooved guide-wheels for the ropes were also fixed, the buckets being swung from the stationary ropes by little overhead runners and crooks. The buckets most generally used were constructed of hide, as being more durable than the common iron buckets, and the ropes were often made of twisted hide, till the introduction of iron and steel wire ropes gradually superseded all others. Arrived at the level of the platform, the bucket was tipped into a narrow shoot, down which the ground ran into a bag held ready to receive it, in which it was conveyed away to be sorted. The din and rattle of these thousands of wheels, and the twang of the buckets along the ropes were something deafening, while the mine itself seemed almost darkened by the thick cobweb of ropes, so numerous as to appear almost touching one another. This mode of haulage, of which the illustration opposite conveys an idea, continued in vogue during the whole of 1873, and if the appearance of the mine was less picturesque than while the roadways existed, it was, if anything, more unique. By moonlight, particularly, it was a weird and beautiful sight.

The year 1874 witnessed the establishment of the first Kimberley Mining Board, the internal affairs of the Mine having been previously managed by a Diggers' Committee. The excavations by that time were over 100 feet deep, and with the increasing depth many unforeseen difficulties arose, which the newly constituted Board had at once to grapple with. The first of these difficulties was an accumulation of water in the lowest workings. Then the encasing rock of the mine (or the "Reef," as the diggers called it) being exposed by the removal of the diamondiferous ground, began to disintegrate, and fall into the mine. Claim-holders in the centre of the mine generally suffered most from the water, those near the margin were most troubled by the reef; but it soon became a recognised principle that both reef and water should be treated as common enemies, and accordingly a general rate was levied on the whole mine to deal with them. The water difficulty would never have been serious, had anything like adequate pumping machinery been provided, as no strong springs were met with in the workings, and it was mainly surface drainage that had to be coped with. Much more serious have been the reef troubles, forming a long chapter of accidents in themselves, which more than once threatened to involve the whole mine in ruin; and though all this is now ancient history, no account of the diamond industry would be complete, that did not devote some space to the reef question, which was once so all-engrossing at Kimberley.

The first necessity was to provide more powerful hauling machinery than the hand-tackle hitherto employed. The "horse-whim" was introduced in 1874, a large timber wheel, some 14 or 18 feet in diameter, fixed horizontally 7 or 8 feet above the ground, with an iron hoop reaching down to the level of the horse's or mule's collar. The hauling-rope, wound several times round the whim, had its two free ends attached to two buckets, one of which ascended from the mine as the whim revolved, while the other bucket was lowered down. This enabled larger tubs of 5 or 6 cubic feet capacity to be used, till the introduction of steam engines in the following year gradually replaced all other methods of haulage. It may seem strange, that the advent of steam power was so long delayed, but when it is borne in mind, that the cost of transit from the coast was £30 to £40 per ton, and that no one could foresee the diamondiferous ground would have extended to such an unprecedented depth, surprise on this score vanishes.

Indeed, in reviewing the history of diamond mining in South Africa, the perfectly novel features of the industry must never be forgotten. It is easy to look back and criticise, but for the pioneers of the industry there was absolutely no previous experience to be guided by. It was a perpetual groping in the dark, and a necessary waiting for events, and the wonder is, that with all the drawbacks of the situation so much should have been accomplished.

To deal more effectually with the reef removal, the Mining Board erected costly hauling machinery at the north-east and south-west corners of the mine, at the same time sinking a large vertical shaft through the reef at the north-east corner, some 200 yards back from the limit of the claim-ground. At a depth of 286 feet from the surface, the hard amygdaloid rock was struck, and the further sinking of the shaft abandoned. But it is deplorable that no tunnels were driven towards the mine on the surface of this rock, as they might certainly have been used for removing a large quantity of dangerous reef from the north and east margins, which subsequently fell into the mine, and had to be hauled out by the claimholders at an increased cost, after serious stoppage of payable work.

Early in the year 1878, one quarter of the claims were covered by reef; this was being hauled out at a cost to the Board of 4*s*. per load of 16 cubic feet. In the years 1879 to 1880, the Board's expenditure on the removal of reef, débris, and water, exceeded £300,000, although the reef-tariff had been reduced from 4*s.* to 2*s.* 6*d.* per load. At the end of 1881, the Mining Board had 7 miles of tramway in use, while another 12 miles had been laid down by claim-holders. During that year, the Board expended over £200,000 in reef removal, but the work had been commenced too late to be effective, the slips became ever greater, so that in 1882, more than *half a million sterling* was needed to defray the cost of the reef actually removed, and still claims were covered, and other slips impending. The bulk of this removal had been done by the claim-holders themselves at the Board's expense. A couple of private shafts had been sunk some years previously, one on the north (Central Company), the other on the south reef (French Company), at distances of about 450 and 650 feet respectively from the limit of claim-ground, and through these shafts a quantity of the solid reef was removed, the fallen reef from the lower claims being hauled out by the aerial trams, which consisted of four thick standing ropes (steel wire) 4 to 5 inches in circumference, each pair of ropes serving as a tramway for a large tipping-tub of 16 to 32 cubic feet capacity, slung in a frame running on four grooved wheels. A third shaft, sunk through the north-east reef in the latter part of 1882, was used for lightening the top reef in that part of the mine, while inclined tramways, cut in the reef on the west and east sides of the mine, were conducting similar operations in the open. Notwithstanding all these appliances, the reef removal did not keep pace with the constantly recurring slips. The tariff had been raised again, in October, 1881, to 3*s.* 9*d.* per load, and during the following eighteen months, the reef hauled by claim-holders alone cost the Board over £650,000. Unable to meet this heavy expenditure by cash payments, the Board had recourse to bills, with the result that by the end of March, 1883, its books showed a deficit of over a quarter of a million sterling.* The local banks refusing then to discount its reef-bills any further, a financial crisis arose, causing a dead-lock in the operations of the mine. Outsiders freely stated that Kimberley Mine was ruined.

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* See Report to the Government by Mr. E. A. Judge, Civil Commissioner of Kimberley, Blue Book G. 107, 1883.

The dilemma was really a most grave one. The financial position of the Mining Board rendered a continuance of heavy reef-work in the absence of outside assistance impossible. Still less could any individual claim-holders contemplate reaching their submerged ground by means of tunnels connected with shafts sunk outside the mine; the expense of boring through the "hard rock," besides being too costly, was too lengthy an operation to afford the speedy relief that was needed. At this juncture, Mr. Edward Jones, a mining engineer, who had been conducting large reef contracts for some time previously, propounded a scheme which, though startling in its novelty, and poohpoohed by most practical miners at the time, was shortly afterwards carried into effect by the inventor at his own risk, and which actually enabled the mine to tide over its gravest difficulties. The question was, how to get out diamondiferous ground at once without the prosecution of further dead work.

Mr. Jones solved the problem in the following manner:—A shaft was sunk *inside the mine* through the fallen reef, on the "cofferdam" principle of gradually lowering a square timber box, without bottom, though the loose stuff, shovelling out the reef from the inside, and fixing on box after box to the first one, till it had sunk to the bottom of the fallen reef, forming a strong timbered shaft within the latter, and resting at last on the solid blue ground. In this mode more than fifty feet of loose reef were successfully sunk through, after which the shaft was easily extended to any desired depth into the "blue," and tunnels were driven in all directions, so as to continue the excavation of the mine underground. The great merit of the scheme was, that it entailed little initial outlay, while as soon as the "blue" was reached, the work of opening up the galleries more than paid for itself in the value of the diamondiferous ground removed, which was reached within a few months after starting the shaft.

Jones' shaft was sunk at about the deepest part of the mine, in Claim No. 320 of the Central Company's ground, and was speedily followed by similar shafts in other parts of the mine, and though it was soon apparent that this system of mining could not be carried on permanently, it met the crying need of the hour, in raising a supply of blue ground, in the absence of funds, to continue reef-hauling on a large scale, or to sink expensive shafts through the hard rock outside the mine. In 1882, three million loads of reef had been hauled, for one million loads of blue. In 1883, only one-and-a-half million loads of reef were hauled, with the result that the greater portion of the mine remained submerged, so that in that year the output of blue fell to 350,000 loads. On the 4th of November, 1883, about the biggest fall of reef on record took place, estimated at 250,000 cubic yards,* and in that one day half as much rubbish fell into the mine as had been hauled out during the whole year, at a cost of a quarter of a million sterling. That the mine was able to survive such a disaster, was signal proof of the marvellous richness of the property. The Report for 1883, of Inspector of Diamond Mines, contains a most interesting detailed account of this great reef-fall, the first threatening indications of which were discovered fully six months previously, first by surface cracks in the red soil, and in the sloping face of the reef, and subsequently by the appearance of a soapy vein, or slide, in a tunnel nearly three hundred feet underground. By means of an indicator fixed in this tunnel, the rate of movement of the superincumbent reef was constantly measured, and was found to increase, between May and October, from half an inch per week to nearly half an inch per day. Then the collapse came, and the huge mass slowly subsided, surging half across the mine, where the bulk of it lies to this day.†

By the end of 1882, the deepest open workings in the blue ground of Kimberley Mine were over 400 feet beneath the surface; and they never much exceeded that depth, since it gradually became evident that the task of keeping the claim ground clear of reef was beyond the means of even the wealthiest companies then owning the richest portions of the mine. *Some four million cubic yards of reef had been removed in all, at a cost of something like two millions sterling,* and yet the Inspector of Mines had to report, that out of the 300 or 400 claims in the mine, "only about fifty claims have been regularly worked during 1884." Though profitable mining was being carried on from the shafts sunk through the fallen reef, attempts were still made to revert to open working, which ruined both systems; as hauling reef from the foot of the slopes caused a further subsidence, which carried away these shafts, and destroyed many thousand pounds' worth of machinery and plant used in connection therewith. In each of the years 1884 and 1885, the quantity of blue ground raised from Kimberley Mine was little over 300,000 loads, which practically demonstrated that mining in the open could not be conducted below a depth of 400 feet, and that the only alternative was some system of underground mining.

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* The "load" is 16 cubic feet of loose stuff, equal to 10 cubic feet of shale in the solid, and to 9 cubic feet of solid "blue;" so that a solid cubic yard of blue is equal to 3 loads, and a solid cubic yard of reef to about 2¾ loads.

† See section of Kimberley mine, facing p. 54.

The experience gained at such great expense in Kimberley Mine, was naturally made use of to avoid similar mistakes in *De Beers Mine,* in which the expenditure on reef-work has been comparatively insignificant. For the first few years after its discovery, little attention was devoted to this mine, owing to the greater richness of Kimberley Mine on the surface; but when the reef-troubles in the latter mine became so serious as to render a large amount of capital necessary for coping with them, mining at De Beers was energetically resumed. The hard basaltic rock overlying the shales stood remarkably well when exposed, so that for several years very little trouble was caused by falls of marginal or "main-reef," which was cut back in terraces as it became dangerous, thus keeping the claims generally clear of reef. In the years 1878 to 1882 inclusive, the De Beers Mining Board had removed over 215,000 cubic yards of reef at a cost of £76,000, being much less than the average cost of similar work in Kimberley Mine, where the bulk of the reef had to be hauled out after it had fallen into the claims. But as the mine grew deeper year by year, the amount of dead-work to be done rapidly increased. In each of the years 1883 and 1884, over 70,000 cubic yards of reef were removed, and yet in the early part of 1885 such considerable falls of reef took place that the Board determined to cease reef-hauling altogether, as certain in the long run to bring disaster on the mine. The deepest open workings had by that time reached a depth of about 350 feet below the surface, and the richness of the blue ground over a great portion of the mine had been proved to be almost equal to that of Kimberley, but still there was much hesitation and timidity about resorting to underground mining.

In both mines, as already mentioned, there is a great difference in the relative value of the ground in different parts of the mines—the claims in the west end of both mines being not payable, whilst those in the east, north, south, and centre, are exceedingly rich, though showing again minor variations to a considerable degree. The west end of De Beers Mine had remained a high bank of unworked yellow-ground, and a few weeks after the reef-falls referred to above, some 300,000 loads of this high yellow-ground fell in one day, filling up the whole of the lower blue-ground workings, and actually overlapping the foot of the reef, which had fallen from the east of the mine, so that for the next six months profitable work in the open was suspended till this rubbish could be cleared out.

Though the De Beers Mining Board had never any serious trouble with reef or water, individual claim-holders were hampered for many years by a great belt of "floating reef," or shale destitute of diamonds, which covered a large number of claims at or near the surface to a depth of several hundred feet, and which had to be removed at the expense of the claim-holders concerned, many of whom were ruined in the process; although it was suspected, and has since been proved, that this floating shale would disappear at a greater depth, and that rich blue-ground would be found underneath it. Some ten or twelve years ago, this floating reef stood up as a high wall dividing the mine into separate "gullies," in one of which, known as the "Australian Gully," water accumulated to such an extent during an exceptionally rainy season, as to reduce the owners of some of the richest ground in the mine to the verge of bankruptcy. In the lower levels now being worked underground, this floating reef has almost entirely disappeared. In the same manner, a smaller mass of rock, imbedded in the blue, known as "The Island," and analogous to the melaphyre, which originally covered some three or four claims, and which has been exposed to a depth of over 700 feet, is found to be gradually reducing in area.

Prior to the great falls of reef and yellow ground in the beginning of 1885, a move had been made towards inaugurating underground mining, on a more ambitious plan than that adopted in Kimberley Mine, by means of a large circular shaft, sunk some 1000 feet to the north of the mine. This shaft was commenced in 1884, and carried down 320 feet, and then abandoned in favour of an inclined shaft, sunk about 150 feet west of the claim margin, at an angle of 56° with the horizon, so as just to cut through the edge of the "hard rock," and thus avoid the great expense of sinking and driving through the amygdaloid. At the same time mining in the open was still proceeding, but by the end of 1886, the reef-falls had become so serious as to render a continuance of this system hopeless. By that time the greatest depth in the open workings was 400 feet, and in underground mining 650 feet, and in the course of the following year the latter system was universally adopted, and all idea given up of attempting to remove the marginal reef and high yellow ground, which have since been allowed to slide into the mine where they have long since covered every vestige of the old open workings.

A second inclined shaft, known as "No. 2 incline," was sunk from the west end of the mine, parallel to the first incline, but of larger dimensions, and a large vertical shaft was also sunk on the north side to communicate with the mine at the 800 feet level. The former shaft was completed by March, 1888, and on the 11th of July of that year a most deplorable loss of life was caused through the destruction by fire of the No. 1 incline shaft. The following account is given, by the Inspector of Mines, of this awful calamity. "By some undiscovered means an underground timbered shaft, between the 500 and 700 feet levels, took fire, and the flames quickly travelled through a connecting tunnel—close timbered—to the No. 1 incline shaft, up which, being an up-cast, the fire tore rapidly, and within about 20 minutes that shaft was useless and practically wrecked. No. 2 incline, which had been disabled for winding purposes in the morning, through a skip running off the rails, but still available for escape, was also an up-cast, and dense volumes of smoke from the burning timber soon filled this shaft to suffocation. An old disused shaft at the eastern end of the mine, and the old tunnel into the open mine at the 380 level, where the aerial gear formerly worked, were the only sources of fresh air. According to returns furnished after the disaster, 24 white men and 178 Kafirs were killed, mostly through being asphyxiated by the smoke. There were at the time of the outbreak of fire 67 white men and 625 Kafirs at work underground."

The formation of *Dutoitspan Mine* is similar to that of Kimberley and De Beers, but owing to its much greater size, and the inferior richness of the ground, it has not reached the same stage of development, nearly all the work having been done in the open. The encasing rocks consist of yellow and black shales, the latter of unknown depth. For the first five or six years after its discovery this mine was only spasmodically worked, and the results were so little encouraging that, in 1874, most of the diggers left Dutoitspan, to work "débris" at Kimberley,* and in the following year the mine was almost completely deserted. In 1876, the débris-washers returned, took out fresh claims, and by degrees introduced improved hauling and washing machinery, so that the mine rapidly grew deeper; but as the ground was not rich enough to pay for much dead-work, a buttress of unexcavated blue-ground was generally left as a solid support against the reef, and served to stave off the evil day for a number of years. A disastrous reef-fall, however, took place on the 18th of March,

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* *Débris* is diamondiferous ground outside the mines, the remains of *dry-sorting* in the years previous to the introduction of washing machinery.

1886, by which 8 white men and 10 Kafirs were killed. Surface-cracks had been noticed in the northern margin of the mine for 18 months previously, but not sufficient attention was given to the signs of impending subsidence. On the day in question, all the workers were supposed to have left the mine at noon, and the blasting had commenced, when a huge mass of reef and solid blue-ground detached itself from the almost perpendicular side of the mine, and curling bodily over, fell with a crash like an avalanche into the workings below. Unhappily, a party of miners had taken shelter during the blasting in a pumping-engine house at the bottom of the mine. The house was completely wrecked by the falling rock, and the unfortunate 18 men were either crushed or scalded to death. The fallen mass was estimated at 100,000 cubic yards, of which about one-third was blue-ground. This was the first serious reef-fall in Dutoitspan Mine, and was followed at intervals by others, till at the present time nearly all the old open workings, which by the end of 1887 had attained a depth of 400 feet, are covered with reef. In this mine, too, there are considerable masses of floating reef and high poor ground, which divide the mine into a number of gullies, in some of which the accumulation of water has at times converted a large area of claim-ground into temporary lakes.

The history of *Bultfontein Mine* is not unlike that of Dutoitspan. For the first ten years it was worked by means of inclined roadways and bullock-carts, but from 1880 onwards the erection of powerful hauling machinery enabled increased quantities of "blue" to be excavated, and by the end of 1887 the deepest working had reached a depth of 460 feet, probably the greatest depth ever reached in open workings in any of the mines. A plucky attempt was made by one of the companies to avert the inevitable fall of the reef, by cutting it back in terraces, but the work was commenced too late, and confined to only one corner of the mine; the forces of Nature slowly but surely prevailed against the exertions of man, and by the middle of 1889 nearly the whole of the deep claims were covered by reef, and by the end of that year only four hauling gears were still working out of more than thirty that had been at work in 1882. Bultfontein Mine has always been exempt from any troubles with water in the claims, but a considerable area is covered by large blocks of floating reef.

It has been shown how, in each of the four mines, the difficulties of mining increased with increasing depth, requiring constantly larger capital, and more elaborate appliances for winning the diamonds. As a natural consequence, the individual digger, who had held his one or two claims and been able to work them at a profit while near the surface, was soon compelled to sell out, or to amalgamate with his neighbours. With a laudable desire to allow as large a population as possible to acquire separate holdings in the newly-discovered mines, it was originally decreed that no individual should hold more than two claims, and the "blocking" of claims was also prohibited. But as early as 1874, it was found necessary to permit as many as ten claims to be held by a single digger, and even this restriction had soon after to be repealed, as it was found impossible in many cases, particularly in the two poorer mines, to work so limited an area at a profit. Thus, the "original digger" gradually gave place to a comparatively small number of capitalists, who by the end of the "seventies" had acquired the richest portions of all the mines, and much of the poorer ground also. Though many of these individual claimholders and private firms, in Kimberley and De Beers at all events, were reaping handsome profits, the growing need of working on a more extensive scale naturally suggested the formation of companies with increased capital, so as to deal with the large amount of dead-work which had to be carried on simultaneously with the mining in payable ground; and in the years 1880 to 1881, most of the private holdings in the four mines were converted into limited liability companies. In many cases, the capital at which these properties were floated was fully justified by the intrinsic value of the claims. In too many others, the *claim* capital was much too high, while the *working* capital provided was ridiculously small; insufficient, in not a few instances, to pay for the necessary machinery and initial expenses, so that many companies found themselves heavily in debt before they had fairly started work.

But a speculative mania had taken possession of the public, and mining scrip was regarded as a sure passport to wealth. One has almost forgotten the names of all the companies, whose glowing prospectuses figured in the daily papers in those days of sweet but short delusion. Within the space of a few months, the promise of certain fortune to investors was held out by more than a hundred Diamond Mining Companies, and it rarely happened that any of these failed to be floated, or their shares to be rushed up to a big premium. The eagerness to be "in the swim" silenced every prompting of prudence: clerks threw up their situations, merchants left their stores, and professional men their duties, to hang about street corners and dabble in stocks, of the real value of which they were generally profoundly ignorant. Three or four years of considerable commercial prosperity had made money plentiful in the colony, but it was speedily all gambled away. So great was the demand for fresh stocks, that claims which were known never to have paid for working were floated almost as easily as the richest proved properties. Nor was this speculation by any means confined to the old-established mines. The number of "Kopjes," the number of "Fonteins," the number of "Pans" and "Dams," that were suddenly discovered to be rich in diamonds, has almost faded from our memory. But the swift retribution which followed has not been forgotten, nor is it likely to be, by those who passed through the succeeding years of depression. We had converted all our available cash into paper, and suddenly the paper was found to be "not negotiable," and of course, when the bubble burst, the really genuine concerns suffered with the rotten ones. For the next three or four years, investors were as hard to convince of the value of our mines, as they had previously been recklessly eager to buy into them.

Meanwhile, the mines themselves were labouring under manifold disadvantages. The benefits expected to accrue from the blocking of holdings were long in being realised. In many Companies the management was entrusted to in-competent hands. During the bright days of speculation, the directors found the Share Market more profitable than work in the mine or the board-room. Owing to increased demand, by the starting of so many new Companies, the prices of labour, food, and material, rose considerably, and, far from any attempt at co-operation amongst the claimholders, their energies were too frequently wasted in litigation, to the utter disregard of their common interests. In the flotation of many properties the obvious truth was forgotten, that a poor mine may pay the individual digger working with only primitive appliances, and yet may not pay for a staff of high-salaried men. The want of funds often compelled the ground to be rushed through the washing machines before it was properly pulverized, whereby a large percentage of diamonds was lost. Indeed, the whole process of diamond-mining, which has since been reduced to a science, was carried on with little knowledge or system in those days. The simplest elements of economy were disregarded; the loosest kind of check was kept on expenditure, and even on the diamonds themselves. So it is not surprising, that out of seventy Companies originally existing in the four mines, more than half either became insolvent, or had to be wound up, and passed out of existence. Several Companies in Dutoitspan and Bultfontein, which had never paid a dividend to the shareholders, were let out on tribute, and often yielded considerable profits to the lessees, who were generally hard-working men, keenly alive to the importance of giving all their time to the personal superintendence of the mine.

The immediate result of the formation of Companies was to greatly increase the output, with the aim of paying dividends on the enhanced capital of the mines. From having been little over two million carats in 1879, the production of diamonds for each of the years 1880 and 1881 rose suddenly to over three million carats,* so that the mines became rapidly deeper, and the difficulties of working a single mine harmoniously by a number of different proprietors grew more palpable every year. There were constant disputes, and costly law-suits, between the several claimholders, or between these and the Mining Boards, often resulting in awards for enormous damages; and as early as the beginning of 1883 the Inspector of Mines, in his Report on Kimberley Mine for the previous year, informed the Government that "it is daily becoming more evident that this mine, especially, can never be worked to the best advantage until all the payable holdings have been amalgamated and the whole mine worked as a single holding." Kimberley being the smallest and deepest of the four mines, this state of things was reached there soonest, but the conclusion forced upon an impartial and competent observer of Kimberley Mine, was admitted to be applicable to the other mines, by those most interested in them. If this was true in the days of open workings, it left no room for doubt after the underground works had been started, which rendered it more difficult than ever for neighbouring claimholders not to hamper and hinder one another. In both Kimberley and De Beers mines, six or eight different shafts had been sunk, some inside, some outside, the mine, connected with tunnels, galleries, and passes, worked on half-a-dozen systems. In 1885, there were four different systems of underground mining in vogue in Kimberley Mine, and, apart from the inconvenience of this, the waste of money to the mine, regarded as a single property, was almost incalculable. The far-seeing directors, therefore, in both mines, began early to impress on their shareholders the importance and advantages of amalgamating adjoining blocks, with the ultimate view of converting the whole mine into a single company. The process, however, was both long and tedious, necessitating endless discussion as to the relative value of the different properties concerned, and it was only by slow degrees that first one bit of ground, and then another, was welded on to that of a richer neighbour, so that every year the number of separate holdings grew less and less. What a Herculean task was involved in this project will be realised when it is mentioned, that by the end of 1885, after considerable progress had been made in amalgamation, there were still no fewer than 98 separate holdings in the four mines. Of these, 42 were Companies, and 56 private firms, or individuals. In Kimberley, there were 11 Companies, and 8 private holders; in De Beers, 7 Companies, and 3 private holders; in Dutoitspan, 16 Companies, and 21 private holders; and in Bultfontein, 8 Companies, and 24 private holders. The total claim-area leased in the four mines was 3238 claims, equal to only 68½ statute acres: yet the assessed value for rating purposes was over five millions sterling, equivalent to an average of £75,000 per acre, and the market value, of course, was considerably higher. The total number of claims, in Kimberley Mine, was 331; in De Beers, 591; in Dutoitspan, 1430; and in Bultfontein, 886. It should be mentioned, that the size of a claim, in Kimberley and De Beers, is 31 feet by 31 feet, and in Bultfontein and Dutoitspan, 30 feet by 30 feet, so that in the former two mines about 45⅓ claims go to an acre, and in the latter about 48½ claims.

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* See Appendix II.

It will be seen from the above figures, that the greatest progress in amalgamation had been made in De Beers Mine, where the number of separate holdings had been reduced to seven Companies owning the whole mine, with the trifling exception of nine claims held by three private diggers. The most important of these Companies was the *De Beers Mining Company.* Founded on the 1st of April, 1880, with a capital of only £200,000, it had by degrees absorbed most of its smaller neighbours, till by the end of March, 1885, its capital stood at £841,550, on which, during the last financial year, it had paid a dividend of 7½ per cent., the largest dividend thus far earned by the shareholders. In the three following years, the policy of amalgamation was not only steadily pursued, but was expanded into a broader scheme for uniting the principal holdings in all the mines into one powerful corporation, which should control the whole of the diamond industry. By the end of 1887, the amalgamation of De Beers Mine was complete, and controlling interests had been purchased in each of the other three mines. At the close of the financial year ending 31st March, 1888, the capital of the Company stood at £2,332,170, and the increased dividends, that had been paid during the last three years, fully justified the directors in expecting the approval of their shareholders for their bold exercise of the powers vested in them under the trust deed. The dividends for 1886, were 12 per cent.; for 1887, 16 per cent.; and for 1888, 25 per cent., in each case for the year ending 31st March. During the eight years of the Company's existence, the total dividends paid had exceeded a million sterling, being 71⅔ per cent. on the figure at which the capital had successively stood, and in addition to these dividends, 41 per cent. had been distributed in bonus-shares. Two very gratifying circumstances had contributed towards the improved position of the Company: first, a very marked improvement in the value of the "blue"; and, secondly, a great reduction in the cost of working. In 1881, the "blue" had only yielded $\frac{7}{10}$ths of a carat per load, and in 1882, only $\frac{8}{10}$ths carat, while the working expenses had amounted to 13*s.* 2*d.* per load, so that in that year it had cost 16*s.* 6*d.* to produce a carat of diamonds. In 1887, the average yield was 1·15 carats per load, and the cost of production 8*s.* 2*d.* per load, equivalent to 7*s.* 2*d.* per carat, so that in those five years the yield had improved over 40 per cent., and the cost of production been reduced nearly 40 per cent. In the former year a dividend of only 3 per cent. had been paid; in the latter year the dividend was 16 per cent. And yet, in the meantime, there had been a most serious drop in the selling price of diamonds, namely, from 27*s.* 3*d.* per carat in 1882, to 18*s.* 5½*d.* in 1887.

No better proof could be afforded of the benefits resulting from amalgamation than the foregoing figures.* It is well known that the mine had grown richer as it grew deeper, but this greatly improved yield was partly due to better management, and to the stronger financial position of the Company, which enabled a large reserve of "blue" to be kept on the floors, thus ensuring the ground being thoroughly pulverised before it was washed. At the end of 1882, the De Beers Company had only 3000 loads of blue on the floors; at the end of 1887, they had nearly 300,000 loads on the floors. The im-

* Compare, also, the figures in the Table of Statistics of De Beers Consolidated Mines, Appendix V., page 138.

proved yield is also partly attributable to the better precautions taken against theft of diamonds, by the introduction of the "Compound" system, which secured complete surveillance over the native labourers. The great reduction in working expenses was mainly due to the much larger scale on which operations were conducted as the size of the property increased. From having treated less than 100,000 loads in 1882, nearly 500,000 loads were washed in 1887; or, in other words, while the capital of the Company had been barely doubled, the amount of profitable work performed had increased five-fold.

But this satisfactory improvement, in the cost of production, and in output, was not without its attendant dangers. In the days of open workings, the mine had never been able to produce more than half-a-million carats annually. In the years 1887, and 1888, consequent on the successful inauguration of underground mining, the output of De Beers Mine rose suddenly to a million carats per annum, raised from only one shaft, lifting 2500 loads (of 16 cubic feet) of blue per day of 24 hours. In his report for the year ending 31st March, 1888, the General Manager reported, that two other shafts were in course of construction, each capable of hauling twice, or three times, as much "blue" as the above, and that the quantity of unbroken blue-ground "in sight" above the 800 feet level was over seven million loads. A similar state of things was known to exist in Kimberley Mine, and though the works in the latter mine had not reached the same stage of development, it was merely a question of time, and each of the two mines would have been able to produce as much as the total output of the whole of the Diamond Fields in previous years. An entirely new problem had therefore to be faced: How to prevent over-production?

It is unnecessary to describe the lengthy negotiations which resulted in the formation of the powerful Corporation now known as the De Beers Consolidated Mines, Limited. Readers may refer for full details to the interesting speech made by the Chairman, Mr. C. J. Rhodes, on the 31st March, 1888, at the special general meeting of the shareholders of the De Beers Mining Company, who by their unanimous votes confirmed and adopted the whole programme for "the consolidation of the Diamond Mining Interests." On that day the De Beers Mining Company practically ceased to exist, the shareholders receiving two fully-paid £5 shares in the De Beers Consolidated Mines, Limited, for every fully-paid £10 share in the old Company. The Trust Deed of the new Company is similar to that of the old one, with the exception that it contains larger powers, and further that it provides for five Life Governors, who are remunerated for their services by a portion of the profits, after 30 per cent. per annum has been paid in dividends, in return for which they have to keep in the Company, jointly, an amount of shares equal to about £750,000 at present market value. They are further bound to offer any diamond interests they may acquire, first to the Company at cost, and are not allowed to promote the formation of any diamond company without the consent of their own Company. The first and present Life Governors are, the Hon. Cecil John Rhodes, M.L.A., and Messrs. F. S. P. Stow, B. I. Barnato, M.L.A., and Alfred Beit.

Having thus acquired the whole of De Beers Mine from the late De Beers Mining Company, together with its interests in the other three mines, the Consolidated Mines devoted themselves to completing the task of regulating the production; and were so far successful, that in their Second Annual Report, for the year ending 31st March, 1890, the Directors were able to announce "that the object with which the Company was originally started has at last been accomplished, and the four diamond-producing mines of De Beers, Kimberley, Dutoitspan, and Bultfontein are now practically under the control of the Company." The first and most important step towards consolidation was to secure the whole of Kimberley mine, as being the greatest producing factor after De Beers. This was facilitated by the fact, that the Kimberley Central Diamond Mining Company had, by successive amalgamations and purchases, become possessed of the whole mine. That mine had undergone considerable transformation since the date to which our retrospect brought it some pages back (see page 33). The blue-ground hoisted through the temporary shafts inside the mine had enabled the leading companies to pay off their debts, and to commence paying substantial dividends, and had placed them in a financial position strong enough to bear the expense of sinking shafts outside the mine. The Central Company, in an incredibly short time, rushed down an inclined shaft at the west end, and the Standard Company a similar shaft at the north-east corner, of the mine, and every facility was at hand for fighting De Beers in the matter of production, when Mr. Rhodes' policy luckily frustrated a ruinous competition that could have benefited nobody. Having first purchased the French Company, and resold it to the Central Company (which had meanwhile acquired the Standard and many smaller companies), the De Beers Directors quietly commenced buying up shares in the Central Company, till by the end of March 1889, their interest in the Kimberley Mine was represented by 176,592 £10 shares in the Central Company, and debentures of that Company to the amount of £500,000. They were thus in a position to make advantageous terms for their shareholders for the acquisition of the whole of Kimberley Mine, which was shortly afterwards completed.

In dealing with Dutoitspan and Bultfontein a different principle was adopted, since these mines had, with few exceptions, never yielded any profit to their shareholders, but yet were serious elements as producing factors. For several years they had each produced over half-a-million carats annually, and though this production was rapidly declining, owing to the reef troubles described above, there was always the danger that these poorer mines might fall into the hands of rival financiers. Among the assets taken over from the old De Beers Company, were a number of shares in the Griqualand West Company of Dutoitspan, and in the Bultfontein Consolidated Company. With both these companies permanent working agreements were entered into by the De Beers Consolidated Mines, by which they obtained practical possession of the companies against payment of an annual rental. During their second financial year they purchased the following properties in the Dutoitspan Mine:—*

The Anglo-African Diamond Mining Company.
The Compagnie Générale (including their interest in the Conivieras Mines in the Brazils).
The Sultan Diamond Mining Company.
The United Diamond Mining Company.

And during the same period they bought in the Bultfontein Mine:—

The Bultfontein Mining Company.
The Spes Bona Diamond Mining Company.
The South African Diamond Mining Company.

	£
The total purchase price of these Companies amounted to .. .. about	2,564,000
Besides which, payments were made in cash for sundry investments, conversion of Kimberley Central Shares, transfer fees and stamps, cost of liquidation of Kimberley Central Company .. .. about	211,210
For British South African Company Shares .. „	91,000
For commission and charges raising Second Debentures, &c. .. .. about	81,300
For cost of placing "blue" on the floors .. „	298,890
Making in all a total of .. .. „	£3,246,400

To meet this outlay:—

	£
Second Debentures, £1,750,000, were created at issue price .. .. about	1,660,000
De Beers Bultfontein obligations (given in purchase of the Bultfontein Mining Company) .. .. about	745,400
And 146,464 Shares in the Consolidated Company of Bultfontein Mine held by the De Beers Consolidated Company, which were given in exchange to some of the purchased Companies at the rate of .. about	156,000
	£2,561,400
Leaving a balance paid out of profits for the year ending 31st March, 1890, of about	685,000
	£3,246,400

The actual cost of the properties controlled by the Consolidated Mines has been something like £14,500,000, but it was decided not to increase the capital of the Company beyond £3,950,000, the successive purchases being paid for by the issue of debentures, and the Bultfontein obligations mentioned above. The following is the complete balance-sheet and profit and loss account for the year ending 31st March, 1891,

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* See De Beers Report for 1890.

The figures speak for themselves and will convey an idea of the strong financial position of the Company, and of the magnitude of its operations:—

LIABILITIES AND ASSETS,

		£ s. d.	£ s. d.	£ s. d.
CAPITAL:				
Nominal			£3,950,000 0 0	
Less unissued			1,045 0 0	
				£3,948,955 0 0
DEBENTURES:				
De Beers 1st Debentures		£2,250,000 0 0		
Do. 2nd do.		1,750,000 0 0		
			4,000,000 0 0	
De Beers Bultfontein Obligations			745,400 0 0	
Griqualand West D. M. Co. Debentures			158,000 0 0	
				4,903,400 0 0
BULTFONTEIN MINE SUSPENSE ACCOUNT				98,619 13 4
SUNDRY CREDITORS				42,868 15 4
LONDON OFFICE ACCOUNT				4,201 13 6
INSURANCE FUND				25,000 0 0
UNCLAIMED DIVIDEND WARRANTS				1,178 0 10
INTEREST ACCOUNT:				
INTEREST DUE TO DATE ON THE FOLLOWING:—				
De Beers 1st Debentures		£20,625 0 0		
Do. 2nd do.		24,062 10 0		
			44,687 10 0	
Griqualand West D. M. Co. Debentures			2,765 0 0	
Griqualand West D. M. Co. Shareholders	Companies leased by us		13,034 11 0	
Consolidated Co. Bultfontein Shareholders			8,496 2 0	
				68,983 3 0
PROFIT AND LOSS ACCOUNT:				
AVAILABLE BALANCE				717,829 0 3
Amount set aside to date for the redemption of De Beers 1st Debentures due 1st August, 1891			144,843 15 0	
Amount set aside to date for the redemption of De Beers 2nd Debentures due 1st January, 1894			112,656 5 0	
Sinking Fund in connection with De Beers Bultfontein Obligations			34,704 16 10	
				292,204 16 10
				£10,103,240 3 1

31st MARCH, 1891.

Claim Account		£7,457,888 6 2
INVESTMENTS:		
De Beers 2nd Debentures (£72,000) ..	£527,217 15 11	
210,000 £1 fully paid shares British South Africa Company		
26,324 £1 fully paid shares Consolidated Company, Bultfontein		
30,739 £10 fully paid shares Griqualand West D. M. Company		
6,755 £5 fully paid shares De Beers Consolidated Mines, Limited		
Sundry Investments	103,886 7 8	
Kenilworth Estate and Village	56,735 6 10	
Waaldrift Farm (½ share)	12,895 3 6	
		700,734 13 11
MACHINERY AND PLANT		385,744 11 7
Furniture		5,118 6 10
Stocks (Merchandise, Coal, and Produce) ..		50,137 14 7
Live Stock		12,886 2 1
Property (Offices, Stores, Compounds) ..		103,596 14 7
Sundry Debtors		12,773 7 0
Dutoitspan Mine Suspense		28,523 5 4
Cape of Good Hope Bank (in liquidation) ..		12,740 5 5
DEVELOPMENT WORKS:		
De Beers Mine	68,798 17 1	
Kimberley Mine	22,479 5 3	
		91,278 2 4
SHAFTS:		
De Beers Mine	59,000 0 0	
Kimberley Mine	49,637 3 5	
		108,637 3 5
Stock of Blue Ground		493,431 16 11
Diamonds on Hand		143,122 11 3
Cash in Hand and in Standard Bank ..		96,082 1 8
London Office—Cash and other Securities ..		400,545 0 0
		£10,103,240 3 1

W. H. CRAVEN, Secretary.
W. PICKERING, Accountant.

PROFIT AND LOSS

	£	s.	d.	£	s.	d.
CHARGES:						
Auditors' Fees (Two years)	£1,200	0	0			
Bonus Account	4,406	10	0			
Directors' Fees	11,100	0	0			
Donations, Relief, &c.	9,628	3	4			
General Charges	33,717	2	1			
Interest Account	6,901	6	7			
Law Costs	6,641	3	10			
Rents, Licenses, and Taxes	7,124	2	3			
				£80,718	8	1
WORKING EXPENSES:						
Hauling (including Maintenance Machinery £37,072 16 8)	527,045	8	6			
Washing (including Maintenance Machinery 59,024 14 7)	416,233	6	4			
				943,278	14	10
London and Paris Office Expenses				3,642	1	9
Mashonaland Expedition (Expenses to date)				8,728	17	8
Interest on Debentures and De Beers Bultfontein obligations to date	263,072	12	6			
Interest due to Leased Companies to date	96,392	10	0			
				359,465	2	6
Insurance Fund (additional amount on Machinery and Property)				6,250	0	0
Debenture Expenses				39,417	3	6
Cape of Good Hope Bank in Liquidation—Estimated loss of 5*s*. in £ on our claim of £50,961 1*s*. 6*d*.				12,740	5	4
Amounts Written off Machinery, Property, Furniture, and Investments				209,438	13	0
Amounts Written off Blue Ground at Dutoitspan and Bultfontein				215,000	0	0
Amount Written off Shafts and Development Works				92,737	10	1
Sundry Balances in connection with the Purchase of Companies written off				4,353	4	8
				1,975,770	1	5
Balance				1,334,408	15	10
				£3,310,178	17	3
Dividends Paid 30th June and 31st December, 1890				789,791	0	0
Amount set Aside for Redemption of Debentures				292,204	16	10
Available Balance Carried Forward				717,829	0	3
				£1,799,824	17	1

ACCOUNT, 31st MARCH, 1891.

Dividends on Investments	£22,450	13	10
Diamond Account	3,287,728	3	5
	£3,310,178	17	3
Balance Brought Down	1,334,408	15	10
Balance Brought Forward from Last Year	465,416	1	3
	£1,799,824	17	1

W. H. CRAVEN, Secretary.
W. PICKERING, Accountant.

It will be seen from the above accounts that the nett profit for the year exceeded a million sterling, out of which two half-yearly dividends were paid of ten per cent. each. The actual cost of winning over two million carats of diamonds was little over a million sterling, practically ten shillings per carat, including all expenses at the mines, all office charges and expenses of management. But out of the gross profits over £500,000 were written off for depreciation under various heads, and nearly three-quarters of a million sterling expended in interest on debentures and obligations, and in making provision for their redemption. Omitting the amount of £292,000 odd set aside for redemption, the total expenses of the year were under two millions, or roughly, at the rate of eighteen shillings per carat. The diamonds found, on the other hand, were sold at the average rate of nearly thirty shillings per carat, leaving a nett profit of nearly twelve shillings per carat.

During the financial year to which the above accounts refer the Company produced 2,195,112 carats of diamonds, which realised (including the proceeds of diamonds from débris washing) £3,287,728. According to the Cape Statistical Register for 1890, the total weight of diamonds produced by all the mines in the Kimberley division during that year was 2,415,655 carats, so that apparently about ninety per cent. of the total production is in the hands of the Consolidated Mines.*

To describe with any degree of fulness the gigantic operations conducted by this Company, with its elaborate machinery and mining appliances and its army of workpeople, would require a much larger space than the limits of this work will permit. A brief sketch only can be given of the modern methods employed for winning the diamonds, and those desiring further details must consult the Technical Report issued by Mr. Gardner F. Williams in 1890, and the Reports of the Inspectors of Mines for the last three or four years, and also the Annual Reports of the De Beers Directors.

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* Appendix V.—De Beers Report for 1892, shows that in the fifteen months following the period to which the above accounts refer, the profits and dividends of the Company have been considerably increased, while the working costs have been reduced, and a very substantial reserve fund has been created. See p. 131.

As regards, first, the actual excavations within the mines, the miscellaneous systems of underground work that were hastily planned in the days prior to consolidation, have all been abandoned in favour of a uniform system that is now in vogue over the whole claim area worked in both De Beers and Kimberley Mines. The system originally adopted in the former mine was as follows: "Tunnels were driven across the mine from west to east about 120 feet apart. These tunnels were connected with each other by two tunnels running north and south, one near the west side of the mine and one midway between it and the east margin of the mine. From the east and west tunnels, short offsets 10 feet long were driven every 36 feet. At the ends of the offsets galleries were driven 18 × 18 feet in cross section. The levels were 30 feet apart. When the galleries were driven 18 feet high, there remained a roof of blue ground 12 feet thick and a pillar 18 feet thick on both sides. It was found in practice that the galleries which were driven full size from the offsets were difficult to maintain and became unsafe for the workmen.

"In order to avoid this a change was made in the system of working. The offsets are now driven to the surrounding rock, or when between two parallel tunnels, until they meet. When near the rock they are widened out into galleries, these in turn being stoped on the sides until they meet, and upwards until they break through the blue ground. The 'reef' partially fills the open space. The workmen then stand on the fallen reef, and drill the blue ground overhead. As the roof is blasted back, the reef follows. When stoping between two tunnels, the blue is stoped up to the débris about midway between the two tunnels. The upper levels are worked back in advance of the lower levels and the works assume the shape of irregular terraces.

"The main levels (or levels from which the blue is hoisted) are from 90 to 120 feet apart, with intermediate levels every 30 feet. Hoisting is done from only one level at a time through the same shaft. All the ground lying between two main levels is dumped into shoots, and passes down to the main level, where it is loaded into trucks and sent to the shaft, tipped into the skips and hoisted to the surface. The tipping arrangement at the bottom is very simple, and consists of an iron shoot without a door. While the loaded skip is being hoisted four end-tipping trucks are placed in position, and the door catches loosened. The four doors are held closed by two natives. Directly the lowered skip is seen to pass the shoot the trucks are tipped, and the tipping is done with such rapidity that it frequently occurs that the engine-driver receives the signal to hoist before his engine has fairly stopped.

"The skips at De Beers No. 2 Incline Shaft hold 64 cubic feet, or four 'loads' weighing 1600 lbs. each. The amount of ground hoisted through this shaft from April 1st, 1889, to March 31st, 1890, was 1,355,089 loads, equal to 1,084,071 tons of 2000 lbs." As much as 400 loads have been hoisted within an hour from a depth of 700 feet (or 840 feet on the incline).

The section of Kimberley Mine reproduced herewith will convey an idea of the general formation of the diamond-bearing pipe, with its encasing rocks, and of the main shafts and workings which have been constructed therein. The New Rock Shaft on the north side of the mine was started in March, 1889, and is connected with two main tunnels, one at 1000 feet, the other at 1200 feet from the surface, the distance from the shaft to the mine being about 1134 feet. The shaft is 6 feet wide and 20 feet 6 inches long, divided into four compartments, one for pumping, two for hoisting the blue, and one for a double-decked cage to carry the white miners to and from their work.

The machinery has all been specially designed by the mechanical engineer, Mr. Louis I. Seymour, and is all of the most modern type. The pumping machinery consists of a vertical triple expansion condensing engine, driving 14-inch Cornish pumps. The hoisting is performed by a pair of vertical tandem compound condensing winding engines, with Corliss valve gear and reels for flat ropes, capable of hoisting skips holding six loads of blue ground from a depth of 1000 feet in forty-five seconds.* Arriving at the surface, the skips are tipped automatically into ore-bins, from which the blue

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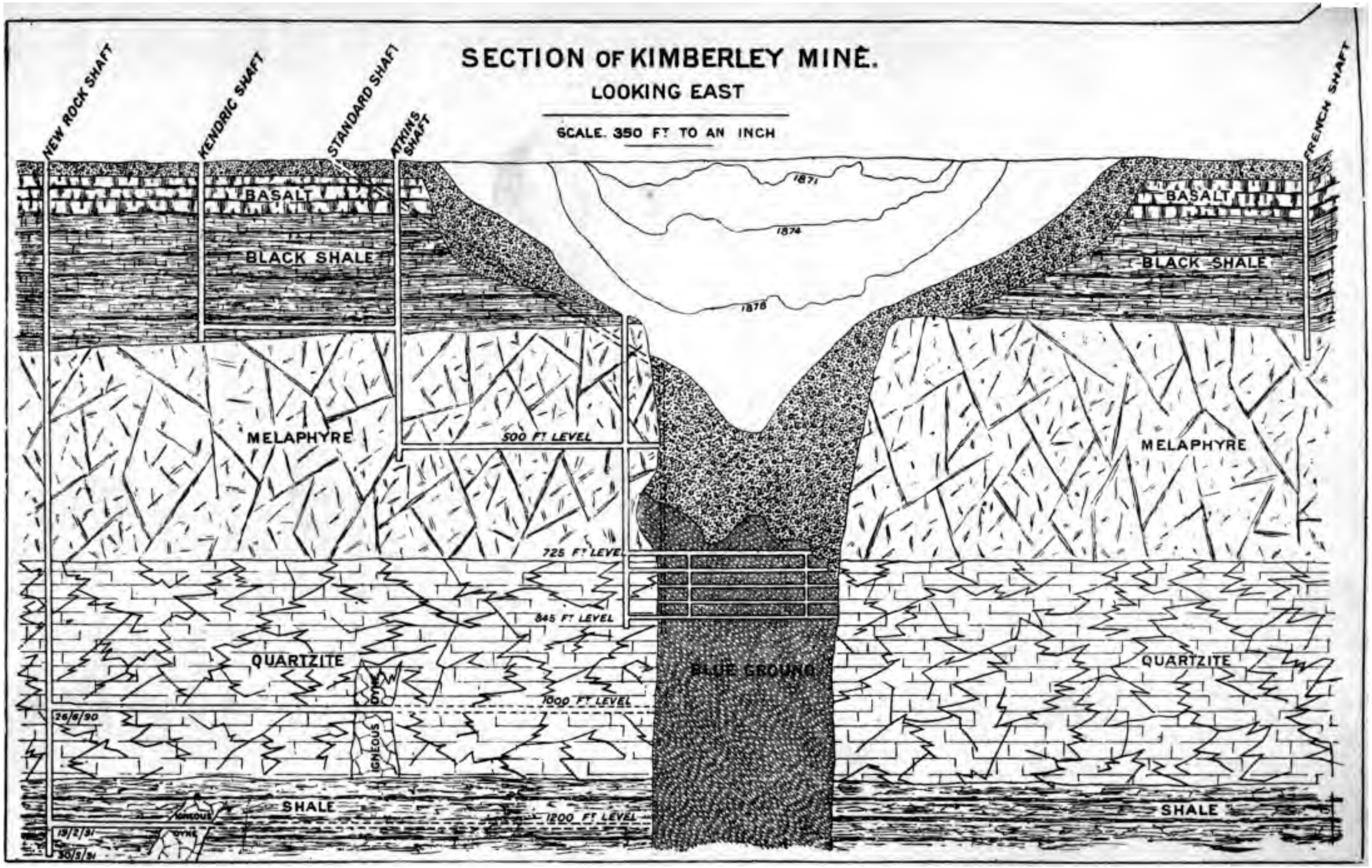
* Appendix VI.—Winding and Pumping Machinery at Kimberley Mine.



SECTION OF KIMBERLEY MINE.

LOOKING EAST

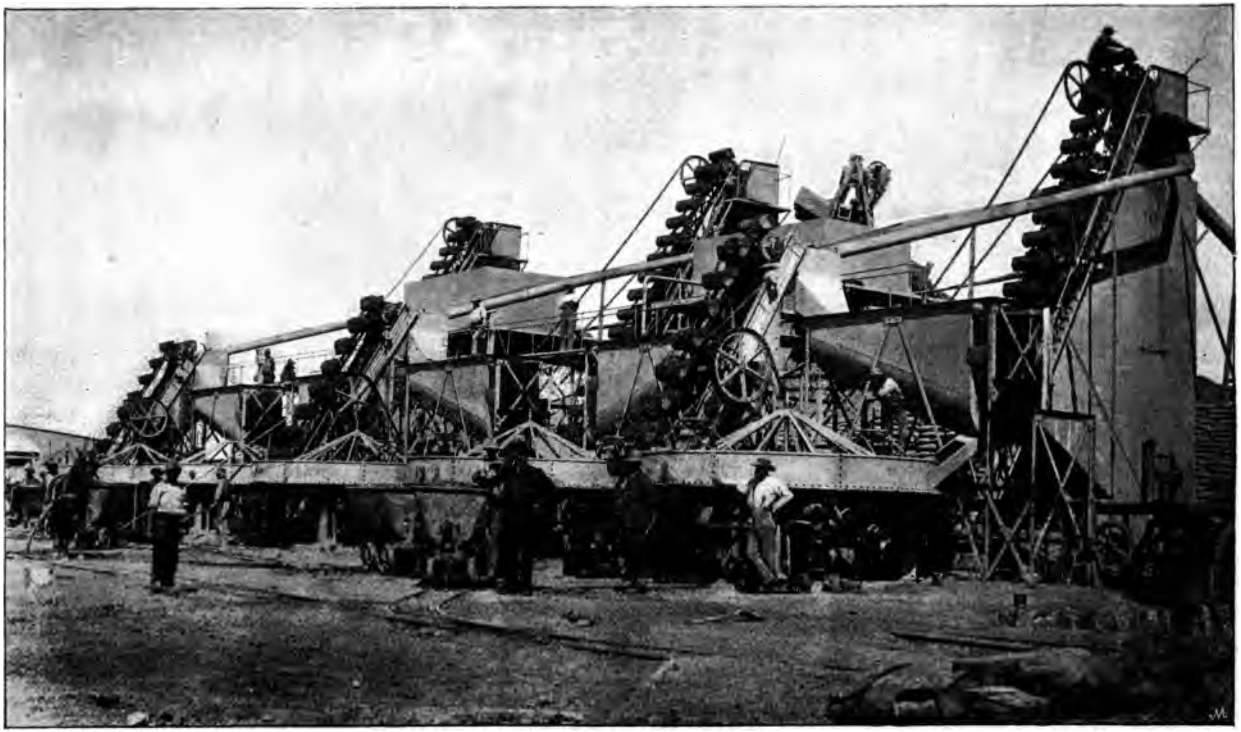
SCALE. 350 FT TO AN INCH

[*Reproduced, with permission, from the De Beers Consolidated Mines Report.*]

[*To face page* 54.

ground is filled into steel side-tipping trucks of twenty cubic feet capacity, and conveyed to the depositing floors by an endless chain haulage driven by an independent steam-engine. The tramways are all 18-inch gauge, and on the floors light locomotives are used for taking the trucks to and from the terminus of the mechanical haulage. There is a slight grade from the mine to the floors, which materially assists the loaded trucks on the down line bringing up the empties. On the floors of De Beers Mine a more elaborate system of endless wire rope haulage is employed, several miles in length. "The length of the main haulage is three miles, with two branches, one mile, and three-quarters of a mile in length, respectively." "The floors commence about a mile from the mine, and extend for three miles in an easterly direction and a mile in a westerly direction." "Besides the main haulage lines, there are two in use taking blue up the inclines at the washing machines, each about half-a-mile long." "The speed of the haulages varies from two-and-a-half to four miles per hour." The trucks are counted automatically as they are sent to the floors, and are also greased automatically. "The depositing floors are made by removing the bush and grass from a fairly level piece of ground. The land is then rolled and made as hard and smooth as possible. The De Beers floors on Kenilworth (a farm of some 17,000 acres, belonging to the Company) are laid off in rectangular sections, 600 yards long and 200 yards wide. Each section holds about 50,000 loads. The depositing is done by horses on portable tram lines extending at right angles from the main lines on either side of the floors." "A load of blue ground (16 cubic feet) weighs about 1600 lbs., and covers about twenty-one square feet when deposited on the floors."

"For a time the blue ground remains on the floors without much manipulation. The heat of the sun and moisture soon have a wonderful effect upon it. Large pieces, which were as hard as ordinary sandstone when taken from the mine, soon commence to crumble. At this stage of the work the winning of the diamonds assumes more the nature of farming than mining. The ground is continually harrowed to assist pulverization, by exposing the larger pieces to the action of the



IMPROVED DIAMOND WASHING PLANT, KIMBERLEY MINE.

[*To face p.* 57.

ment of the ground downwards into the revolving cylinder is regulated by the flow of water through the perforated pipes. The cylinders are 2 feet 6 inches in diameter, covered with heavy wire-netting with meshes 1 inch square, or with perforated iron plates with round holes 1¼ inches in diameter." The size of the mesh differs in different mines, according to the size of the diamonds found there. " As the blue ground enters the cylinders both clear and muddy water are added. It has been found in working that diamonds separate from the mass of lighter materials much better in a properly thick puddle." " The ground which is too coarse to pass through the meshes or holes of the cylinder passes out of the lower end of same" (the cylinder, or revolving screen, is slightly inclined) " into trucks, and is redeposited upon the floors, where it remains for about twelve months, when it is again washed." This coarse ground is technically called " lumps" or " cylinder-lumps." The washing-machine proper consists of one or more shallow annular pans with an inner and outer rim, the latter about 12 inches high and 14 feet diameter, the former about 6 inches high and 6 feet diameter, leaving an annular space between the rims 4 feet across. A vertical shaft in the centre of the pan, driven by bevil-gearing and lay shaft from below, carries ten radial arms, each fitted with six or seven teeth, set so as to form a spiral, so that when the arms revolve (at a speed of about ten revolutions per minute) the teeth, which are set to almost touch the flat bottom of the pan, carry the heavy deposit towards the outer rim, while the lighter material flows towards the centre and is discharged over a weir in the inner rim, and thence into the tailing-pit. The fine ground that has passed the meshes of the revolving cylinder flows down a shoot and enters the pan through a slot in the outer rim. The heavy deposit, containing the diamonds, remains on the bottom of the pan, whence it is drawn off every twelve hours into specially constructed lock-up trucks, which convey it to the "pulsator" for further concentration. " The average quantity of blue ground passed through a pan is from 400 to 450 loads in ten hours.* The deposit remaining in each pan, after putting the above number of loads through it, amounts to only three or four loads." "The tailings pass into tanks and are hoisted in tubs by means of aerial gears, or by means of bucket-elevators, and are deposited in heaps."

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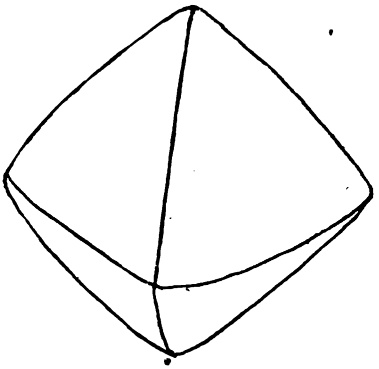
* See footnote, p. 32.

"There are three pulsators in one building on the De Beers floors, where all the deposit from both De Beers and Kimberley washing-machines is manipulated. The operation of the pulsator is as follows:—The trucks containing the deposit from the pans are hoisted in a cage to a platform, where the deposit is fed by means of a shoot into a" long narrow inclined revolving screen, or " cylinder. This cylinder is covered with iron plates perforated with four sizes of *round* holes, $\frac{1}{8}$ inch, $\frac{3}{16}$ inch, $\frac{1}{4}$ inch, and $\frac{3}{8}$ inch in diameter. That portion of the deposit which is too coarse to pass through the screens passes out at the end of the cylinder, where it is sorted. The four sizes which pass through the screens flow upon jigs; these are made stationary, the bottoms being covered with screens, the meshes of which are $\frac{1}{8}$ inch, $\frac{3}{16}$ inch, $\frac{1}{4}$ inch, and $\frac{3}{8}$ inch *square*, which are therefore a little coarser than the plates on the cylinder. Upon the screen a layer of leaden bullets is spread. These bullets prevent the deposit from passing through the screens too rapidly. The heavy deposit, with the diamonds, passes through the screens into pointed boxes below, whence it is drawn off through a pipe at the lowest point of the box and taken to the sorting-tables. The lighter material, or refuse, passes over a lip into a trough, and thence into trucks, by means of which it is hauled away and dumped upon the tailing heap. The following is the proportion of concentration:—Out of 7200 loads washed, 72 loads were sent to the pulsator. Of the 72 loads, 6 pass through the screens, 24 loads pass out of the end of the cylinder, and the remaining 42 loads flow over the jigs as waste. Out of every 240 loads of blue washed, 1 load, or 16 cubic feet, of gravel passes through the hands of the assorters. The assorting is done on tables, first, while wet, by white men, and then, when dry, by native convicts. The deposit is gone over as often as diamonds can be found in sufficient quantity to repay the cost of convict labour."

"The diamond occurs in all shades of colour, from deep yellow to pure white, from deep brown to light brown, and in a great variety of colours—green, blue, pink, brown, yellow, orange, pure white, and opaque. It is the hardest of known substances, and has a specific gravity of 3·83.* The stones vary in size from that of a pin's head to the size of the cut given below. This diamond weighed 428½ carats in the rough (a carat weighs 3·17 troy grains), and is the largest stone ever found in the four mines.† It measured 1⅞ inches through the longest axis, and 1½ inches square. The following cut represents the size and shape of the stone as found.



"It was found in the De Beers Mine by a native, whose 'brother' gave information which led to its recovery, while being taken from the mine. It was cut and exhibited at the Paris Exposition, 1889. Its weight after cutting was 228½ carats, having lost 200 carats in the process of cutting.

"After assorting at the pulsator, the diamonds are sent daily to the general office under an armed escort, and delivered to the valuators of the diamond department. The first operation is to clean the diamonds of any extraneous matter by boiling them in a mixture of nitrate and sulphuric acids. When cleaned, they are carefully assorted with reference to size, colour, and purity. Parcels are then made up, and when valued are sold to local buyers, who represent the leading diamond merchants of Europe. The size of a parcel varies from a few thousands to tens of thousands of carats. In one instance, two or three years ago, nearly a quarter of a million of carats were sold in one lot to one buyer.

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* For further notes on the mineralogy of the diamond, see Jacobs and Chatrian's *Monographie du diamant*, Paris, 1880; also Appendix VII., p. 146.

† But see account of large stone recently found in Jagersfontein, p. 68.

"In order to prevent illicit traffic, the quantities of diamonds found are reported to the Detective Department, both by the producers and by the exporters. All diamonds, except those which pass through illicit channels, are sent to England by registered post. The weekly shipments average from 40,000 to 50,000 carats. The greatest outlets for stolen diamonds is through the Transvaal to Natal, where they are shipped by respectable merchants, who turn a deaf ear to any information from the Diamond Fields to the effect that they are aiding the sale of stolen property. The value of the diamonds stolen was at one time half a million to one million sterling per annum; this amount has been greatly lessened by means of the compounding of the natives. Illicit diamond buying (I.D.B.) is still carried on to a considerable extent, judging from the number of convictions for contravening the Diamond Trade Act." It appears from the Inspectors of Diamond Mines' Reports for 1889, that the number of cases of traffic in illicit diamond buying, tried by the Special Court in Kimberley in the years 1882 to 1889 inclusive, amounted to no less than 1211 trials, of which 831 resulted in convictions, and 380 in withdrawals and acquittals.*

"The compounds for the native labourers employed in the mines are peculiar features of the Fields. Both at Kimberley and De Beers, these compounds, consisting of rows of buildings of corrugated iron, forming four sides of a square enclosed with a high fence, cover several acres of ground. Within these areas, the natives are confined during their term of service, which is generally for three months, at the end of which time many of them re-engage for further periods. Wood and water are furnished free; a large swimming bath is provided; and the sick are taken care of in a hospital, where medical attendance, nurses, and food are supplied by the Company. Wages are paid to the men wholly in money, and within the compounds there are several stores furnished with

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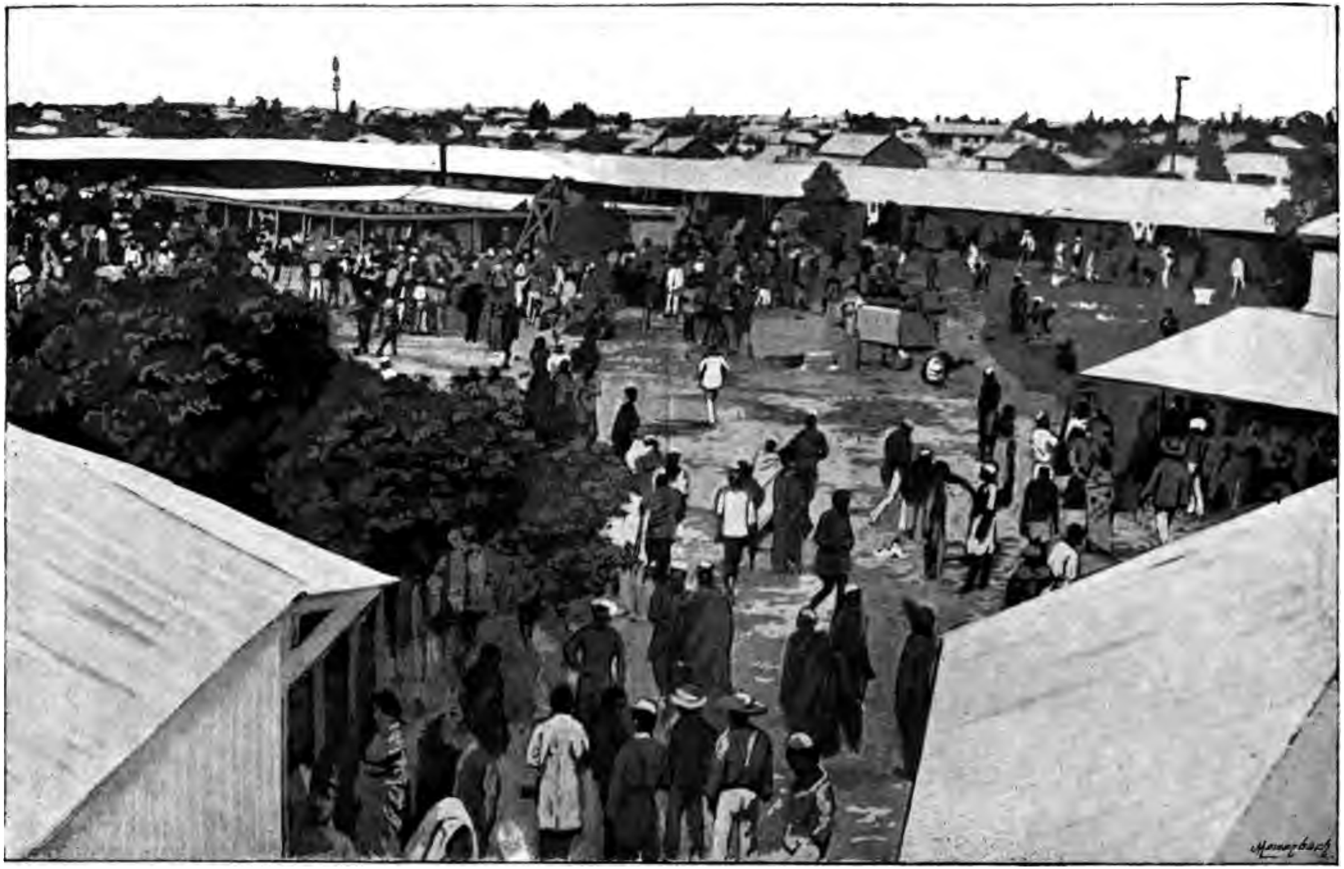
* Appendix VIII.—The Diamond Trade Acts.



NATIVE COMPOUND, DE BEERS MINE, WITH PORTION OF KIMBERLEY, 1890.

all the necessaries of life, where they can purchase food, clothing and whatever they require. No alcoholic liquors in any form are allowed to them, and during the period of service, they are strictly guarded against having any communication with the world outside the compound. The natives are thus provided with wholesome food and healthy quarters, protected from indulging in poisonous liquors, and by a system of close personal surveillance and systematic searching whenever they come up from the mine shafts to the surface, their opportunities or chances of stealing or concealing diamonds are materially reduced. Among these natives are to be found types of all the tribes of South Africa—Kaffirs, Basutos, Zulus, Bechuanas, Matabele, Fingoes, Shangains, Makolakas, &c., and in the open square of the compounds, the visitor who watches the groups of ebony figures draped in blankets, chatting, laughing, gambling, feeding, or sleeping in every imaginable pose, may attain a more realistic picture of native life than anywhere in the interior of the Dark Continent.

" The European employés of the Company are free to live where and how they please; but a model village for the accommodation of a number of them has lately been designed and erected at Kenilworth, near De Beers. Four or five years ago, Kenilworth was nothing but an extensive patch of barren land. Now it is covered with trees, thirty to forty feet high. Roads and streets have been laid out upon it, and comfortable red-brick cottages built, each with its shrub-clad porch, verandah, and flower garden. There were fifty houses occupied towards the end of 1892, and more were in course of erection. Portions of these were for married men and families, others were quarters for single men. The rent of a four-roomed house, with kitchen, offices, and water laid on, is from £4 10*s.* to £5 monthly. Single men have their rooms from £1 a month and 25*s.* per week for board. At the entrance of the village are a church, and a club-house, the latter containing, besides a large common dining-room, an excellent reading-room, where books, magazines, and newspapers are kept, and also a billiard-room with two good tables, the gift of some of the life-governors of the Company. Adjoining the village an orchard has been planted, and about thirty acres of ground covered with 4000 fruit-trees,—peach, apricot, apples, pears, plums, &c.—already bearing fruit, although only in their second season. This orchard is intended to furnish the villagers with fresh fruit at reasonable prices, and any surplus will supply the compounds." *

A few words must be added about the mines and diggings outside the control of the De Beers Consolidated Mines. This Company owns the whole of Kimberley and De Beers Mines, and the greater portion of Dutoitspan and Bultfontein, but is at present doing no work in either of the latter mines. Mining operations had to be suspended owing to reef-falls, and the results of the last year's washing were not very satisfactory. The yield from Dutoitspan Mine was $14\frac{14}{100}$ carats per 100 loads, and from Bultfontein Mine $16\frac{69}{100}$ carats, being the average results obtained from over half a million loads washed from each mine.

In Dutoitspan Mine there are only two companies outside De Beers, viz., the *New Gordon Diamond Company, Limited,* and the *British United Diamond Mining Company, Limited.* The former Company has acquired a large number of new claims on the eastern extension of the mine, in addition to the previous holding on the north reef, and has sunk a large shaft outside the mine, with which it is connected by a tunnel at a depth of 260 feet. Some interesting light has recently been shed on the geological formation of Dutoitspan Mine. At a depth of about 300 feet below the red soil, the Gordon Company has struck quarzite in a drive and pass from its No. 2 shaft, which would appear to indicate that the melaphyre is absent in this mine, a fact (if verified) of considerable importance to the future profitable working of the mine. The Gordon was one of the earliest companies formed in this mine, about twelve years ago, and was known to possess some of the richest claims. The Company was reconstructed under its present title in March, 1891, with a capital of £410,250,† and

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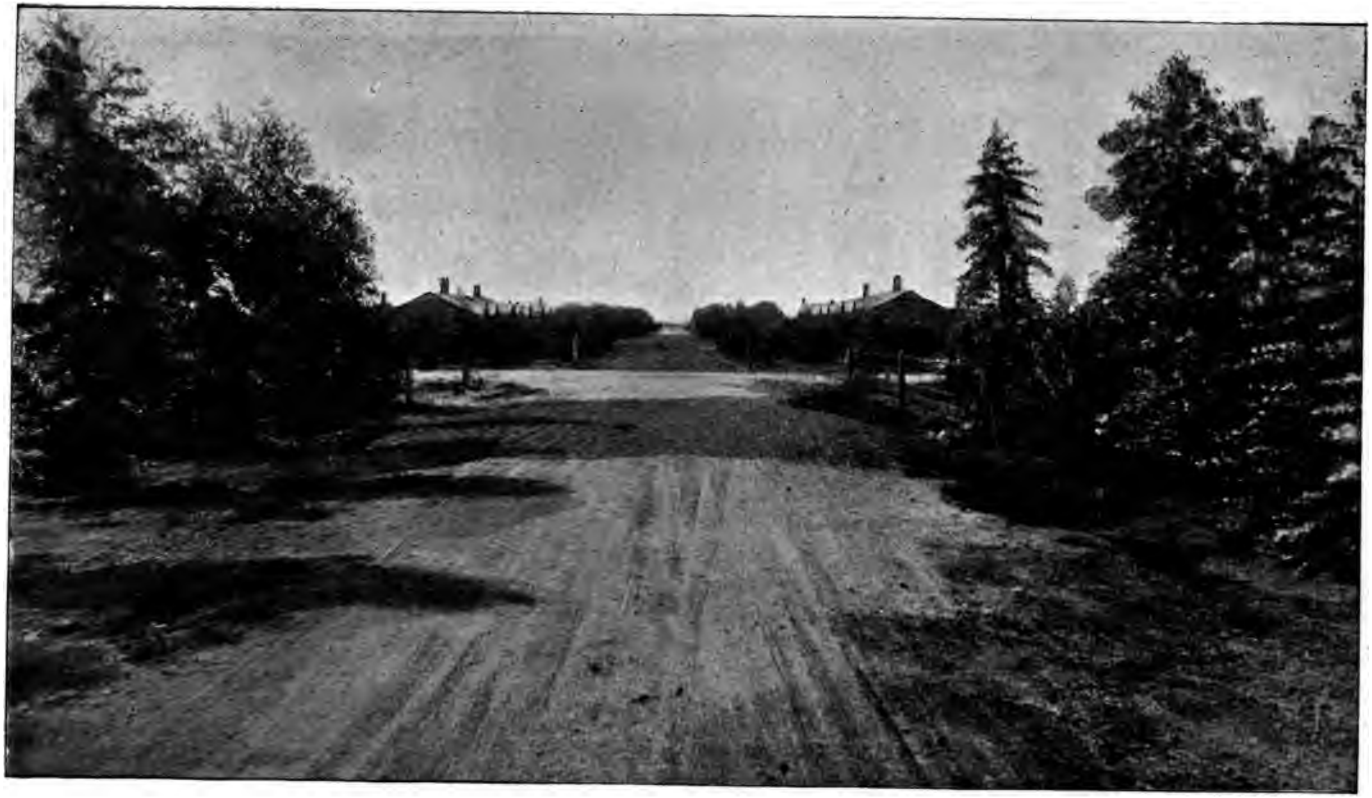
* The two last paragraphs are taken by permission from Mr. John Noble's 'Handbook of the Cape,' 1893 Edition, pp. 347-9.

† At an extraordinary general meeting of shareholders, held in London on the 17th May, 1893, it was resolved to increase the capital of the Company to £560,250 by the creation of 150,000 new shares of £1 each, to be called priority shares.



KENILWORTH VILLAGE, NEAR KIMBERLEY, 1892.

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now owns 435 claims, about half of which are on the "extension," and therefore still in yellow-ground. It is well equipped with machinery of modern type, including a new design of washing gear, in which it is intended to treat the maiden "blue" as it comes from the mine without previous depositing, the ground being first reduced in Blake crushers, and then passed direct to pulsators. The operations of the Company have been much hampered by a great accumulation of water in the mine, estimated at some 60,000,000 gallons, consequent on the stoppage of work in the De Beers claims, and the question as to who shall remove this water is still under consideration by the law courts. The head offices of the Company are in London.

The *British United Company* owns some 70 odd claims on the south reef which are not being worked at present owing to reef troubles. The stoppage of Dutoitspan Mine has caused considerable loss and distress to the tradespeople and population of Beaconsfield, which was a flourishing township in the days when its two mines were in full operation; but it could hardly be expected that De Beers should work these poorer mines at little or no profit, as long as it can win all the diamonds it requires from the two richer mines.

In Bultfontein Mine, apart from the claims of King, Neumann, and Wernher, there is only one independent concern left. This is the *North Eastern Bultfontein, Limited*, the head office of which is in London. Starting with the very small capital of £100,000, this company has by patient development worked up its output to about 1½ million loads in the year. The amount of ground held is very large, amounting in all to 671 contiguous claims. A few of these were included in the old mine, but the greater part were untouched ground forming an extension to the north, which was not formally proclaimed a portion of Bultfontein Mine until late in 1892. Three shafts have been sunk through the yellow and blue ground to depths of over 500 and 600 feet. Two of these shafts are connected at the latter level, at which some 3000 feet of tunnels and passes have been opened up. A large block of claims is also being worked in the open, from which at date of writing (1893), the chief supply of blue is being drawn. The drives from the shafts at the 600 feet level have struck the quartzite, but the depth of the shales is not known, nor has it been ascertained whether the melaphyre exists in this mine. Powerful machinery has been erected, which is sufficient for dealing with the present output, but it is a question whether it would not be more profitable in the end, by increasing the capital, to still further enlarge operations, as there is nothing in the physical conditions to prevent the present output being doubled if necessary. The operations of this company are the mainstay of Beaconsfield, and if this expansion were effected it would do much to restore the township to its former prosperity.

The size of a claim in both Dutoitspan and Bultfontein Mines is 30 feet by 30 feet, for which a monthly rental of thirty shillings per claim is paid to the landlords, the London and South African Exploration Company, Limited. Each claim carries with it one acre of depositing floor, so that the floors of the two mines cover five or six square miles of country. The North Eastern Company derives its water-supply for washing purposes from the "Pan," a natural basin which receives the surface drainage from the surrounding country, and which of late years has grown into a lake of imposing dimensions. A similar lake of smaller size, known as Blanckenberg's Vley, exists about a mile to the north of Dutoitspan Mine, from which the New Gordon Company has the right of pumping.*

The *Kimberley Diamond Mining Company, Limited,* is, in common with the last-named company, an off-shoot of the London and South African Exploration Company, Limited, and was formed in London three or four years ago with a capital of £100,000 for the purpose of prospecting for diamonds on the Exploration Company's property. Its chief work thus far has been devoted to opening up the *Belgravia Mine,* which lies within the township of Kimberley on the farm Bultfontein, within a stone's throw almost of De Beers Mine. The number of claims is said to be about 400. The diamond-drill has been used for prospecting, and in the process of development a quantity of diamonds has been found, including one stone of 58 carats, but the mine appears to be unpayable, as it has been shut down.

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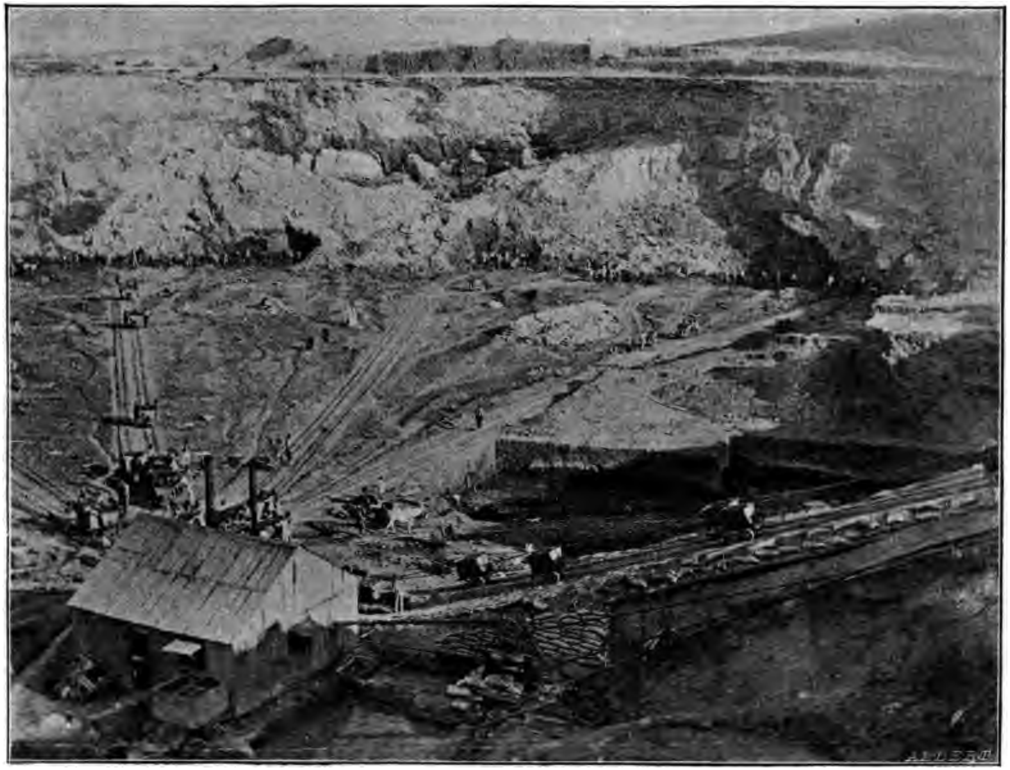
* See Plan of the Diamond Fields, facing p. 3.

The *Saint Augustine's Mine,* so called from the church of that name which stands on the property, was "rushed" some twelve years ago in the days of the first "boom," and is now owned by a London Company, which has erected powerful machinery and done a considerable amount of development down to a depth of 800 feet from the surface, all the mining being underground, but very little is known publicly as to the results obtained. This mine is also situated within the township of Kimberley, only a few hundred yards to the west of Kimberley Mine, and is almost hidden among the houses and gardens of the west-end of the town.

Otto's Kopje is another mine that was rushed in the "boom" of 1880, and after standing idle for many years is now the property of the Otto's Kopje Diamond Mines, Limited, a company recently reconstructed in London with a capital of £500,000, which holds some 500 acres under lease from the Cape Government, including two mines lying a couple of miles to the west of Kimberley. No. 1 Mine has been prospected by means of a shaft sunk to a depth of 1200 feet into the "blue," but the new management is devoting its energy to the exploitation of No. 2 Mine, which it is proposed to work on a large scale as an open mine in the yellow ground, for which purpose extensive machinery is shortly to be erected.

There are several other mines in Griqualand West, most of which were rushed twelve years ago and soon after abandoned, though some of them are now being reopened in the forlorn hope that they may prove payable under the cheaper conditions of working which obtain to-day. But, more important than any of the outside mines mentioned above, is the *Premier Mine* (Wesselton), which was only discovered in the latter part of 1890, though it lies within a mile eastward of Dutoitspan Mine, on the farm Benauwdheidsfontein, part of the Wessels Estate, which has been known for years to contain diamonds, and has been prospected right and left any time these last twenty years. The mine had been overlooked owing to the absence of the ordinary surface indications. It lies in a slight depression, while most of the other mines were originally "kopjes," or slight hillocks, and the diamondiferous soil is covered by a thick deposit of 8 feet or 12 feet of tufaceous limestone. It had actually been used as a depositing site for the dry rubbish of the township of Beaconsfield. The coach road from Kimberley to Bloemfontein passes over the estate, which comprises fifteen farms of a total of 52,000 acres, and is cut in two by the boundary-line of Griqualand West and the Orange Free State, only 6000 acres lying within Colonial territory; but the whole estate is held under a Free State title, which renders the minerals the sole property of the owner of the land. In spite of this, the Premier Mine was "rushed" in the early part of 1891, but the rushers were subsequently turned off as trespassers, and the mine reverted to Mr. H. A. Ward, who had acquired the prospecting rights on the whole estate. He has since entered into an arrangement with the De Beers Consolidated Mines, Limited, whereby the latter company have purchased the entire Wessels Estate of fifteen farms, including the Premier Mine, for the sum of £303,000. Mr. Ward's part of the bargain gives him the right to mine and wash for his own benefit 5,000,000 loads of yellow ground in the five years 1892 to 1896, out of which he has to pay back to De Beers half the above purchase price and interest on the whole at 9 per cent. per annum. He is also bound not to sell more than 20,000 carats of diamonds per month.

There are 1125 claims in the Premier Mine, which, after deducting the area covered by "floating reef," will yield the prescribed quantity of 5,000,000 loads by taking out the yellow ground to a depth of about 70 feet. This will still leave a large amount of "yellow" to be treated by De Beers, besides all the blue ground, which Ward is not allowed to touch. Owing to the great facilities of working top stuff, which is hauled from the mine up inclined tramways, and tipped direct into the washing machines, the yellow ground can be treated



THE PREMIER (WESSELTON) MINE, 1893.

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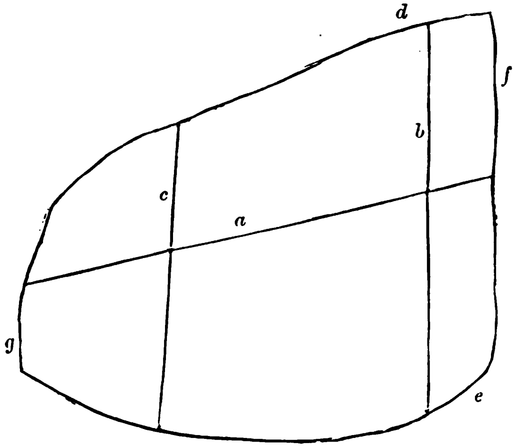
at a cost not exceeding 1*s.* 6*d.* per load, which on a low estimate of its value will leave a nett profit of 2*s.* 6*d.* per load, so that Mr. Ward is likely to make about half a million sterling by his bargain. On the other hand, the property acquired by De Beers is remarkably cheap, and a magnificent addition to the assets of the Company. At present there is ample water in the mine for washing purposes, but the greater part of the "Pan" falls within the property, and is a most valuable water-right.

As already mentioned, there are several diamond mines within the Orange Free State, most of which have been worked spasmodically for many years past. The only mine of real importance is *Jagersfontein,* which was discovered more than twenty years ago, and, after passing through numerous ups and downs, is now the sole property of the New Jagersfontein Mining and Exploration Company, Limited. This Company was formed in April, 1887, with a capital of £132,150, which subsequent amalgamations brought up to £789,150 by the 31st March, 1891, at which date it held 847 claims out of a total of 1124 in the whole mine, the remaining claims being held by the Jagersfontein United Mining Company, Limited, with which the final amalgamation took place in July, 1891. The capital of the New Jagersfontein Company is now £1,000,000, and, in addition to holding the entire mine, the Company owns the total number of shares in the Jagersfontein Mine and Estate Company, Limited, which pays 6 to 8 per cent. per annum on its capital of £100,000, being the proprietor of the farm and drawing licences from all the stands in the township, as well as recovering one-half of the claim-licences collected by the Government. Among the other assets of the Company are 10,000 £5 shares in the De Beers Consolidated Mines, and a remarkable brilliant of 55 carats, found originally in the claims of the Jagersfontein United Company, and taken over on amalgamation. It was previously known as the "Pam" brilliant, but is now called the "Jagersfontein." It weighed in the rough about 112 carats, and is valued at £25,000, being at present on view, and for sale, at Messrs. R. & S. Garrard & Co., of the

Haymarket. Some short time since, the Queen telegraphed for the brilliant to be sent to Osborne with the intention of purchasing it, but the untimely death of the Duke of Clarence put a stop to the transaction.

The fame of the above stone, however, is entirely eclipsed by the wonderful diamond which was found in Jagersfontein Mine on the evening of June 30, 1893, and which is probably the largest and most valuable diamond in the world. Its gross weight is 969½ carats, the colour is blue-white, and the quality very fine. Its value cannot possibly be estimated. It is of irregular shape, measuring no less than three inches through the longest axis. Its other dimensions and general form may be gathered from the following particulars, for which I am indebted to Messrs. Wernher, Beit & Co., of 29 & 30, Holborn Viaduct.



Length (*a*)	about 2½ inches.
Greatest width (*b*)	„ 2 „
Smallest „ (*c*)	„ 1½ „
Thickness at (*b*) end	.. 1¼ „
„ at (*c*) „	.. ⅞ „
Extreme girth in width (taken from *e* to *d*) ..	about 5⅜ „
„ „ length (taken from *f* to *g*) ..	„ 6¾ „

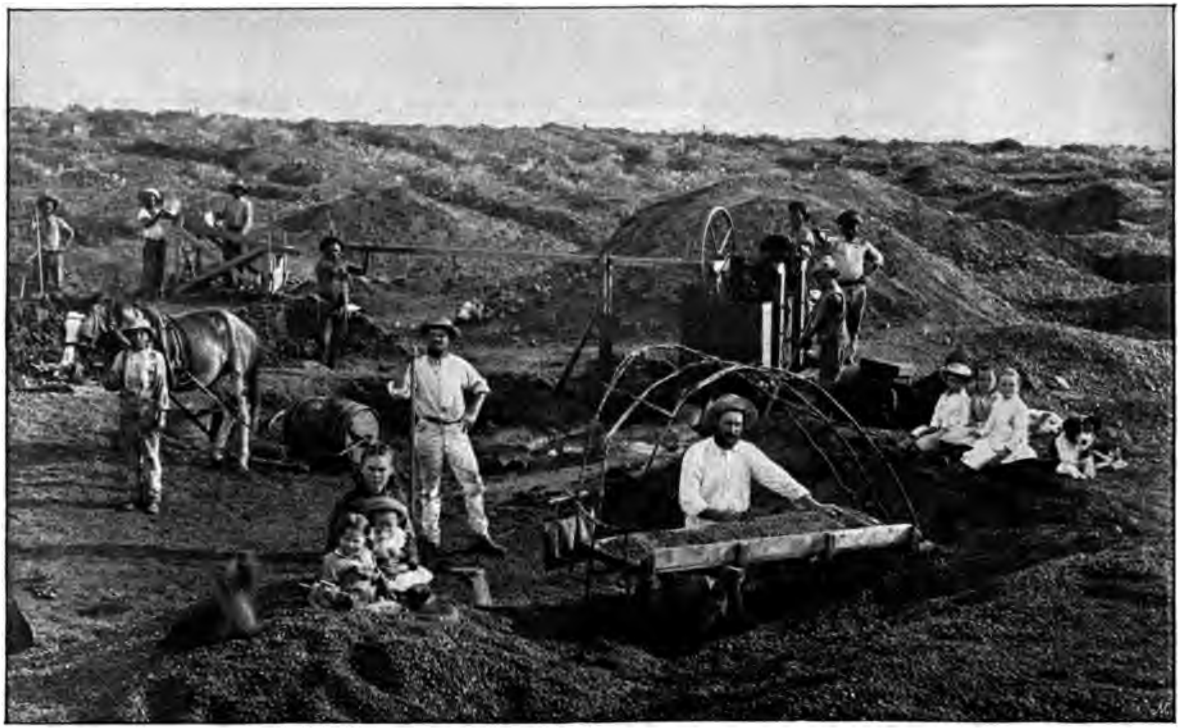
During the financial year ending 31st March, 1892, the New Jagersfontein Company washed 1,156,095 loads of ground, producing 110,171½ carats of diamonds, realised and valued at £195,271 4*s.* 9*d.*, being an average yield of over

9½ carats per 100 loads of blue, and an average value of over 35*s*. 5*d*. per carat. The average price realised for Kimberley and De Beers diamonds during the fifteen months ending 30th June, 1892, was 25*s*. 6*d*. per carat, so that it will be seen the Jagersfontein diamonds are some 30 or 40 per cent. better in quality than those of De Beers. The yield of diamonds from De Beers blue is, however, about ten-fold that of Jagersfontein. Still, the latter mine is being worked at a good profit, and with increasing depth the ground is said to increase in value, while the working expenses have been reduced to about 2*s*. 3*d*. per load, which is a high testimony to the ability and efficiency of the management. The mine has been entirely worked on the open quarry system. According to Mr. George Kilgour's report, the main or marginal reef consists of about 20 feet of slaty shell formation covered by about four feet of red surface soil, and underlaid by a hard quartz rock, to which, up to the present, no bottom has been found, so that the formation is peculiarly favourable to the carrying on of open working to a great depth with safety. The lowest workings are at present about 420 feet deep, and of the whole mine area about 900 claims are being worked. A mass of floating reef, consisting of a hard conglomerate of sand and stones, covers about 224 claims to a depth of some 50 feet, underneath which about 30 feet of unprofitable blue ground is found. The Company has about 1,000,000 loads of blue on the floors, and is in every respect in a sound and flourishing condition, paying regular quarterly dividends of 2½ per cent. The railway to Bloemfontein passes within thirty miles of the mine, so that cheap fuel and produce are now available. The town of Jagersfontein is six miles from Fauresmith, the capital of the district, and about eighty miles from Kimberley, where the head office of the Company is located. The resident managing director at the mine is Mr. William Miller, and the secretary in Kimberley, Mr. Nelson S. Girdlestone.

The only other Free State mine deserving mention is *Koffyfontein*, situated on the Riet River, about fifty miles south-east of Kimberley, in a direct line between there and

Fauresmith. The Koffyfontein Farm is owned by the London and Orange Free State Exploration Company, Limited, who bought it from Mr. Rorich in 1880 for £80,000. A number of companies were formed at that time to work the mine, but all came to grief. In November, 1889, after having remained unworked for several years, the claims were sold by public auction in Kimberley, when 1187 claims realised £70,772, 300 claims being kept in reserve by the proprietors of the farm. The mine was once more proclaimed a public digging, and several new companies set to work. The finds of diamonds registered from December, 1887, to April, 1891, amounted to 9912 carats, valued at £14,640, or an average of nearly 30*s*. per carat. Elaborate waterworks have been constructed by the Exploration Company on the Riet River, for which hitherto there has not been much use, as the mine was again abandoned soon after their completion. Last year (1892) the Free State legislature passed a law declaring the working of claims in Koffyfontein compulsory, under penalty of forfeiture, which has partly induced a return of activity at this mine, where several parties of old Kimberley diggers are once more at work. Besides this, a block of 1000 claims has been taken up by an English syndicate, who intend to thoroughly test the mine on a much larger scale than has ever been attempted before. An inclined shaft is to be sunk to a depth of at least 1000 feet, and large washing gears are to be erected.

The town of Barkly West, pleasantly situated on the right bank of the Vaal River, twenty miles north-west of Kimberley, is the centre of the River Diggings, which extend up and down the river on both banks, a distance of some seventy miles from above Hebron, the oldest diggings on the Vaal, to its junction with the Hart River. These diggings are very unlike the Kimberley Mines, being all in alluvial soil, a heavy deposit of ferruginous gravel mixed with red sand, lime, and boulders, that has been washed into the crevices of the rocks by the action of the river, which has cut its way through a hard volcanic rock, probably diabase, which stretches for miles on either bank, and extends from near Potchefstroom



SORTING GRAVEL AT WALDEK'S PLANT. VAAL RIVER.

[*To face page* 71.

almost to the junction of the Vaal and Orange Rivers. There is little doubt that this rock is identical with the "hard rock," or amygdaloidal melaphyre, of Kimberley Mine. The Kimberley shales thin out and vanish as the Vaal River is approached, and the great sheet of melaphyre appears there on the surface. Whether the diamonds which the heavy deposit contains have been formed *in situ*, or whether they were brought from a distance, is still a vexed question, but the balance of evidence is in favour of the former hypothesis. Most of the diggings are very shallow, but in some cases they are nearly a hundred feet deep before the bed rock is reached. Several companies have been formed at different times for working the deep alluvial, but they have not been very successful, and the fact appears to be that the River Diggings are poor men's diggings, which yield a small return to hard-working individuals, but which do not justify the outlay of much capital. They are still being worked very much as they were twenty years ago, and the original digger is still to be found there with all his primitive appliances, living his free arduous life, often with but scanty fare, and occasionally diversified by a trip to Kimberley. The result of amalgamation has been to increase the activity at the River Diggings, where there are now probably nearly a thousand white men at work, in addition to their native labourers. In 1889, the Government revenue from claim licences, &c., amounted to a little over £6000, being an increase of £1000 on the revenue received in 1888, while in 1890 it rose to £9500. The approximate weight of diamonds found at all the River Diggings has remained pretty constant for several years past, having seldom much exceeded 30,000 carats per annum, that is, about one per cent. of the weight produced at the Kimberley Mines, but the quality of the river stones is superior even to those of Jagersfontein, the former having generally about twice the value of the average price realised for Kimberley stuff. During the year 1890, the approximate weight and value of diamonds imported into Kimberley from the Barkly Division were 28,122⅜ carats, valued at £79,231 11*s.* 3*d.* (data supplied by the Detective

Department), equal to 56*s.* per carat. The value of the production of the Kimberley Mines during the same period was only 31*s.* 1½*d.* per carat.*

There are a number of Dry Diggings in the Barkly District, similar in formation to the Kimberley Mines, but none of them has proved payable.

It is only since the establishment of the Board for the Protection of Mining Interests in 1882, that accurate statistics have been compiled of the value of the production from each mine, and also of the imports of diamonds into, and exports from, Kimberley; but from the Postal and Customs Returns an approximate estimate may be formed of the production prior to 1882. Comparing all available sources of information, it may be confidently stated, that the total weight of diamonds exported up to the end of 1892, has exceeded fifty million carats, of a total value of nearly seventy millions sterling. As about five million carats go to a ton, the weight of diamonds exported has amounted to over ten tons. If piled into a heap, they would form a pyramid 6 feet high, with a base 9 feet × 9 feet; or they would fill a box 5 feet × 5 feet × 6 feet.

The above estimate of the total value of diamonds exported to date (1892) makes a small allowance for the diamonds known to have been exported through private and illicit channels. The Official Return of diamonds exported from the Cape Colony, compiled by the Collector of Customs, gives the total value for the twenty years from 1872 to 1891 inclusive, at £58,110,923. To this must be added at least a couple of millions for diamonds exported prior to 1872, and a further four millions for the exports of 1892, making a total of sixty-four millions sterling from the discovery of the Fields to the end of 1892, so that the above estimate of *seventy millions* assumes only 8½ per cent. of the total to have been illicitly exported, which is probably far below the actual figure.†

For the past five years the value of diamonds exported has remained at between four and four-and-a-quarter millions per annum, and this appears to be the maximum value the market can take without unduly affecting the price.

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* See p. 76, for '1892 Returns from the River Diggings.'

† Appendix II.—Gross Value of Diamonds exported.

It has been shown in the previous pages how the control of the diamond industry has gradually passed into the hands of a powerful Corporation, which for the first time in the history of the Fields has enabled shareholders to depend on reasonable and regular dividends. The annual expenditure in labour, supplies, machinery, &c., may be gathered from the following statement of payments made by the De Beers Consolidated Mines, Limited, in the Cape Colony and in Europe, during the period from 1st January to 31st December, 1891:—

——	Payments made in the Colony.	Payments made in Europe.
	£	£
Wages and payments to contractors	790,000	..
Rents, licences, salaries and incidental expenses	93,000	..
Trade accounts (purchased in Colony)	220,000	..
Produce	23,000	..
Fuel, wood	15,000	..
Plant and mechanical stores, *plus* railage on this and imported stores	75,000	..
Railage on coal	115,000	..
Dividends:—		
Paid in Colony	300,000	..
Paid in Europe	..	588,000
Interest on debentures:—		
Paid in Colony	3,000	..
Paid in Europe	..	253,000
Interest paid to shareholders of companies leased by us	35,700	58,000
Material purchased in London, such as machinery, &c.	..	66,000
£	1,669,700	965,000

Meanwhile, there is no doubt trade and population have declined from what they were some years ago; but it must be borne in mind that many causes have been at work, in addition to the amalgamation of the mines, which largely account for this shrinkage. The northern extension of the railway is one cause, the rise of Johannesburg and the transfer of the share market from Kimberley is another.

The permanence of the leading industry of the Colony, however, is now assured, and, with a yearly expenditure of about a million sterling at the mines, there will always be steady employment for a large number of men at good wages, and a considerable amount of trade. Attempts have frequently been made by the trading and general community of the diamond-fields, not directly interested in the mines, to induce the legislature to interfere, with the object of alleviating distress and bringing about a return of prosperity, by the Government either acquiring and throwing open new mines, or compelling the working of old ones. In 1891, a Select Committee was appointed by the House of Assembly to consider the wisdom of these proposals, but after taking extensive evidence the majority of the Committee were strongly averse to any artificial interference with the ordinary course of trade, or to the Government undertaking any financial responsibility for the promotion of a hazardous and speculative business. The distress and poverty, which were proved to exist in Kimberley, were declared to have arisen from natural causes, such as those indicated above, and it was considered that they must be left to natural remedies.[*] The remedy will, no doubt, be found in the opening up of new centres of industry, which will gradually absorb the poor and unemployed population of Kimberley.

The following interesting statistics are compiled from the Report of the Inspector of Mines, Kimberley, for the year 1892:—

TABLE A.

SIZE OF THE MINES.

Name of Mine.	Area of the Surface-opening in Acres, in the Year 1890.	Area at the Level of the "Hard Rock" in *Acres*.	Area of Claim-ground being worked at end of 1892, in *Acres*.	Number of Claims in 1892.	Deepest Working-Level, in Feet.	Deepest Sinking, in Feet.
					At end of 1892.	
Kimberley .	31·00	4·55	2·69	..	1000	1261
De Beers . .	18·68	10·12	5·97	..	1000	1097
Dutoitspan .	35·05	..	..	1869*	..	..
Bultfontein .	27·00	..	..	1662†	210	..
St. Augustine's	No surface-opening	..	..	..	800	809

* Equals 38½ acres. † Equals 34¼ acres.

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[*] Report of the Select Committee on Griqualand West trade and business. Capetown, 1891.

TABLE B.

Daily Average Number of Persons Employed at the Mines in 1892.

Name of Mine.	Above Ground.		Below Ground.*		Total.		Grand Total.	Rate of Wages per Week.	
	White.	Native.	White.	Native.	White.	Native.		White.	Native.
Kimberley .	372	982	133	822	505	1804	2309	£4 10s. to £6.	21s. in Compounds.
De Beers . .	693	2098†	229	1812	922	3910	4832	Do.	Do.
Dutoitspan .	No record		No record		96	654	750	£3 5s. to £6.	16s. with lodging.
Bultfontein .	No record		No record		186	933	1119	£3 10s. to £5.	16s. 6d. with lodging.
St. Augustine's	9	15	10	13	19	28	47	..	..
Otto's Kopje .	3	54	..	..	3	54	57	..	..
Grand Totals	1359	4736	372	2647	1731‡	7383	9114	..	..

* In the beginning of 1893, the De Beers Company, at the request of their miners, adopted the eight hours shift for all persons employed underground.

† Including 701 convicts.

‡ The percentage of nationalities of white *employés* is as follows:—English, 50; Scotch, 12; Irish, 5; Colonial, 28; European, 3; other, 2; = 100.

TABLE C.

Summary of Accidents in and about the Mines during the Year 1892.

Name of Mine.	Number of separate Accidents.	Number of Sufferers.		Number of Persons Killed.		Number of Persons Injured.	
		White.	Coloured.	White.	Coloured.	White.	Coloured.
Kimberley . . .	37	12	30	5	9	7	21
De Beers . . .	55	9	58	4	29	5	29
Dutoitspan . .	7	0	7	0	3	0	4
Bultfontein . .	37	0	46	0	12	0	34
St. Augustine's .	1	0	1	0	1	0	0
Totals . . .	137	21	142	9	54	12	88
Percentage of total number of *employés*		1·21	1·93	0·52	0·73	0·69	1·20

TABLE D.

Number and Nominal Horse-power of Steam Engines in Position at the Mines at the End of 1892.

Name of Mine.	Class of Engines.									
	Winding.		Washing.		Pumping.		Locomotive and other.		All Classes.	
	No.	Nom. HP.	No.	Nom. HP.	No.	Nom. HP.	No.	Nom. HP.	No.	Nom. HP.
Kimberley .	8	320	4	87	1	100	11	141	24	648
De Beers . .	4	304	9	165	2	56	17	245	32	770
Dutoitspan .	8	130	8	133	3	26	4	40	23	329
Bultfontein .	5	96	2	60	1	16	5	72	13	244
Otto's Kopje .	1	10	1	10	..	..	..	..	2	20
St. Augustine's	2	38	1	16	1	40	1	1	5	95
Totals . .	28	898	25	471	8	238	38	499	99	2106

At Kimberley Mine there were also, on an average, 115 horses and mules in daily use, and at De Beers, 280. No record is given of the number of cattle at work at the other mines.

Fuel.—The cost of coal per ton of 2000 lbs. is returned as follows:—English, £8 10*s.*; Indwe, £3 17*s.*; and Cyphergat, £2 11*s.* 6*d.*; Wood, £2 per 2000 lbs.

Débris Washing.—In addition to the labourers given in Table B, a daily average of 48 white men and 475 natives were employed in débris washing around Kimberley Mine. This process of searching for diamonds is analogous to the re-treatment of tailings on the gold-fields, but the accumulation of diamondiferous* débris on private stands is now almost exhausted. It affords, in most cases, a very precarious livelihood to the workers.

The River Diggings.—"The approximate weight and value of diamonds imported into Kimberley from the proclaimed diggings in the Barkly West Division, inclusive of diamonds found in the proclaimed alluvial diggings in the Kimberley division, during the year 1892, were 64,706⅝ carats, valued at £149,519 1*s.*, to which add 5576¼ carats, valued at £12,454, diamonds found on unproclaimed diggings on riparian farms in the Kimberley division." These returns show an average value of 46*s.* per carat, as against 25*s.* 8*d.* per carat, the declared average value per carat of the total exports of diamonds from South Africa during 1892. (See Appendix II.) It will be noticed that the output of the River Diggings has doubled during the last two years, forming now nearly 4 per cent. of the total value of diamonds exported from Kimberley. "The approximate number of diggers (inclusive of certificated miners) at work on the various alluvial diggings is from 1300 to 1400; of these, about 1000 are white, and the remainder coloured," besides "upwards of 3000 natives, at wages of 10*s.* per week with food, and 15*s.* per week without food." The most actively worked of the alluvial diggings during 1892 were Klipdam, Gonggong, Hebron, Winter's Rush, Waldek's Plant, and Holpan.

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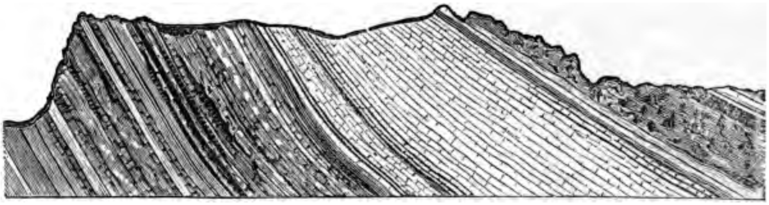
* Though diamondiferous is scarcely an English word, it has been so generally used in connection with the industry for years past, that it is impossible now to suppress it.

PART II.

THE SOUTH AFRICAN GOLD-FIELDS.



Section of Witwatersrand.

THE GOLD-FIELDS.

THE existence of gold in South Africa has been known much longer than the existence of diamonds, but a variety of causes delayed the discovery of the most valuable reefs till only seven years ago. Within four years of the discovery of the first diamond, Kimberley Mine had been discovered, and the extent of the diamondiferous area been pretty accurately defined. The early gold-hunters had not the same good fortune to stumble across the richest mines at the very outset. It is evident from the recent investigations in Mashonaland [*] that gold was worked there many centuries ago, long previous to the Portuguese settlements on the East Coast, probably by the Arabs in pre-Mohammedan times; but it was only twenty or thirty years ago that the travels of Hartley, Baines, Mauch, and others, established the existence of the Northern Gold Fields, and drew the attention of European capitalists to them. In the years 1866 and 1867, this little band of intrepid explorers discovered the Tati fields,[†] and penetrated to the banks of the Zambesi. They announced their discoveries in glowing terms, which time may yet prove to have been not unwarranted; but the difficulty and expense of reaching those then almost inaccessible regions, the dangers and hardships of the journey, and, above all, the superior attractions offered by the Diamond Fields, which were discovered almost at the same time, frustrated their attempts to secure the financial support necessary to follow up their discoveries; and they passed away, as so many pioneers have done, for others to enter into the fruits of their labour.* Two interesting circumstances, however, deserve to be mentioned, as illustrating the irony that attends human effort, even when most wisely directed. In 1869, the late Thomas Baines conducted an expedition from Durban to the gold-fields of Matabeleland. In the course of his journey he passed through Potchefstroom and Pretoria, and, in consequence, close to the present site of Johannesburg, without dreaming of the wealth that was lying under his feet. That is irony number one. The second noteworthy fact is this: in Baines' Map, which accompanies his book on the Gold Regions of South-Eastern Africa, the following entry may be read: "Farm of H. Hartley, Pioneer of the Gold Fields." That farm is actually situated on Witwatersrand, where this famous elephant-and-gold-hunter retired to meditate, no doubt, on the incredulity of the world that would not believe in the existence of gold in South Africa!

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[*] Appendix XV.—Gold in Mashonaland, p. 181; also Appendix XII., p. 163.

[†] Appendix X.—The Tati gold-fields.

We have probably lost all recollection of what travelling meant in this country twenty years ago. From Pietermaritzburg to Tati, a distance of 829 miles, occupied three months by bullock wagon, the only available means of transport. The railway from Cape Town only extended as far as Wellington, a distance of forty-five miles; and to reach the Diamond Fields from there, Baines says, "the road for 386 miles is over a Karroo desert, which in certain dry seasons of the year presents considerable difficulties to travellers." No wonder, then, that with Kimberley mine in full swing, people were content to leave the exploration of the comparatively unknown country north of the Vaal to a future generation. Still, some progress was made. In 1873, the Landdrost of Lydenburg, (about lat. 25°, long. 31°), announced the discovery of alluvial gold, thirty-three miles east of the town. A couple of years previously reef gold had been found a hundred miles further north, at Eersteling and Marabastad, (lat. 24°, long. 30°), and companies were formed in Natal and England to work these various fields, while several more adventurous parties started for the fabulous lands north of the Limpopo.

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* Having reached Lobengula's Kraal, in April, 1870, Mr. Baines received permission from the Matabele King to dig for gold anywhere between the Gwailo and Ganyona rivers. Nearly twenty years later, in November, 1887, Mr. C. D. Rudd secured from the same chieftain the concessions which led to the formation of the Chartered Company.

The discovery of the Lydenburg fields gave the first serious impulse to gold-mining in South Africa, as tangible proof of their value was at once afforded in the shape of the many large nuggets that rewarded the original prospectors, and the alluvial diggings at Spitzkop, Macmac, Pilgrim's Rest, Waterfall, and Rotunda Creek, were scenes of considerable activity in the early years of the seventies. It is said that the number of diggers at work on the Lydenburg fields at one time amounted to 1500 men.* Many reefs were also discovered, but the means for thoroughly testing them were of course not available. In 1875, gold was found in the Kaap valley, fifty miles south of Lydenburg, and though the following year showed a slight increase in the output,† the results were after all disappointing. Then followed the war with Sekukuni, and the more deplorable Boer war, so that it was not till 1882 that the rush to the Devil's Kantoor put fresh vigour into the quest, and once more aroused public interest in the reputed mineral wealth of the country. After the war, the Boer Government had granted mining concessions to a few capitalists, with the idea of driving Englishmen out of the country. The hard terms insisted on by the Lydenburg concessionaires did indeed force the diggers to leave that district, but with the result that, compelled to seek a living elsewhere, they re-discovered the Kaap fields, and thus defeated the intention of the Government, as the new discoveries brought in a larger population of *uitlanders* than ever. As is well known, several Lydenburg properties were floated in London in 1883, but their failure to answer expectations still further delayed the advent of capital from England, and it is to Colonial enterprise that the initial development of the Transvaal gold-fields must be attributed.

In the same year, 1883, the Pioneer Reef was discovered on property belonging to Mr. G. P. Moodie, formerly surveyor-general of the Transvaal, and his farms were floated with a capital of £240,000 by a Maritzburg company. Vigorous prospecting was at once commenced, with such success that in 1885 De Kaap was proclaimed a public gold-field, and the town of Barberton, named after the brothers Barber, arose in what was thought to be the centre of the richest gold-field in the country. There was reason to think so, for the first crushings from the Sheba Reef Gold Mining Company, floated with the modest capital of £15,000, yielded eight ounces to the ton, and the assays of the tailings showed a further four ounces. This wonderful property, previously known as Bray's Golden Quarry, after the discoverer, Mr. Edwin Bray, is a huge hill of gold-bearing rock, and on the strength of its undoubted richness everything in the nature of a reef, either in the immediate neighbourhood, or across the border in Swaziland, was readily floated at any price the promoters cared to name.

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* Appendix XI., p. 159.

† Appendix XXIV.—Value of raw Gold exported from South Africa.

When the account of these discoveries reached England, in September, 1886, the *Times* devoted a leading article to describing the new Eldorado, and the effect of such recognition was simply intoxicating on the Colonial public. The gold-mania had at last fairly taken possession of the country, and much of our available cash was soon sunk in providing capital to work properties, most of which a little investigation would have shown it was hopeless to make payable under the conditions then existing. But when men are gambling in shares they have souls above such petty considerations as dividends. In the boom of 1886, the Sheba Hill was always spoken of as "a mountain of gold" capable of turning out millions. The £1 shares of the Sheba Company rose to over £100, which brought up the selling price of the property to a million and a half sterling; while shares in other Barberton mines, on which absolutely no work had been done, such as the Oriental and the Kimberley Imperial, rose to twenty or thirty times their nominal value. Disappointment and ruin naturally followed, and the Kaap fields have not yet recovered from the ill-repute engendered by the mad speculation of seven years ago.* The Sheba mine alone has to some

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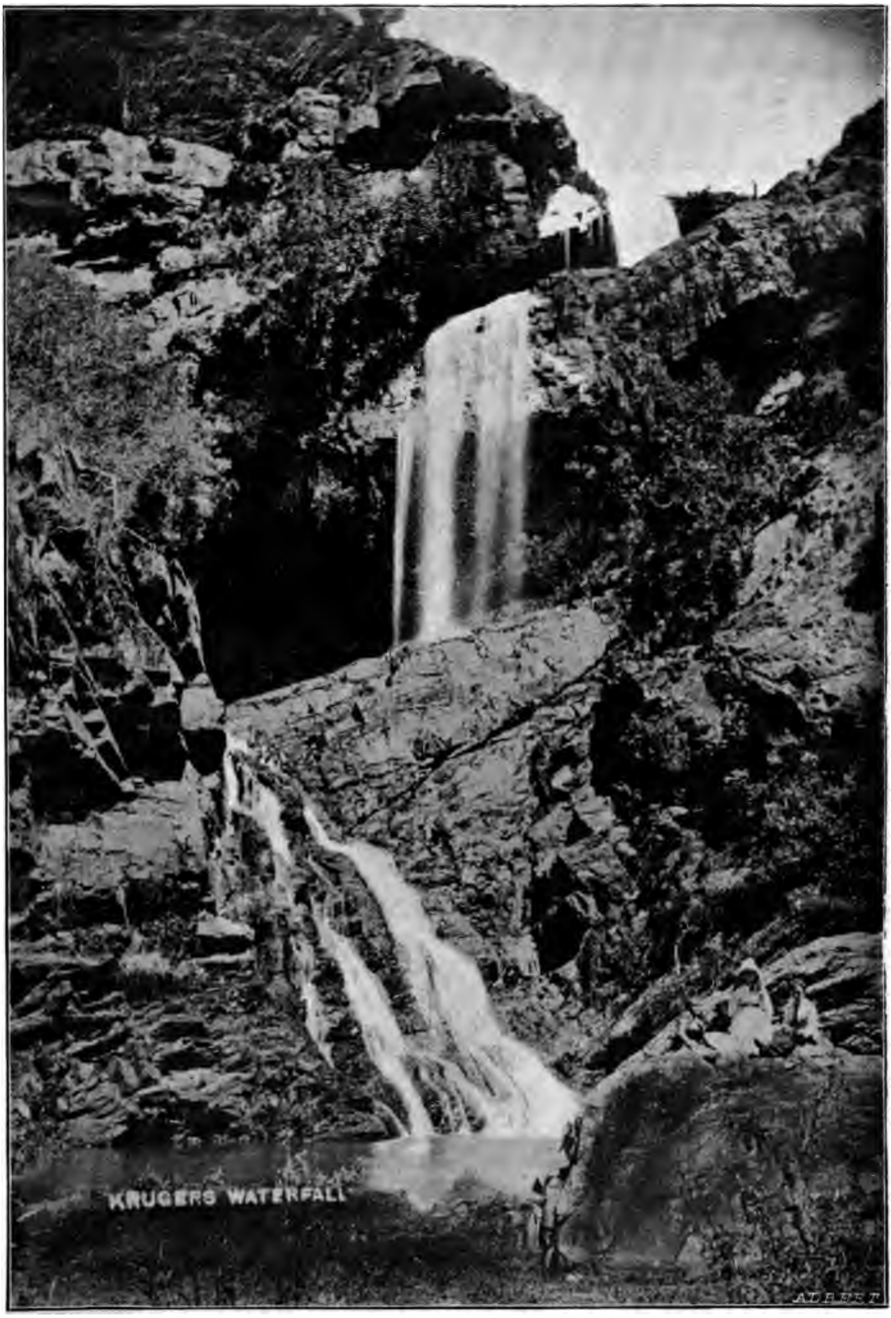
* Appendix XII.—De Kaap Gold-fields.



THE WATERFALL, NEAR KRUGERSDORP, WITWATERSRAND.

To face page 85.

extent justified the original reports of its richness, and stands to-day ninth or tenth in the list of gold-producing and dividend-paying companies in South Africa, turning out regularly about 3000 ounces per month, which is fully half of the total output of the whole of the Kaap and Swaziland fields.* The Kaap, however, is by no means the worst failure that preceded the inauguration of gold mining in South Africa on a sound basis. It is scarcely necessary to revive the memory of the great expectations that were formed of the future of the Malmani fields six years ago, nor, in a lesser degree, of the hopes that were entertained about the same time of establishing a payable field. within the borders of the Cape Colony, at the Knysna.†

It would have gone hard with our reputation as a gold-producing country, and the whole thing would probably have been condemned as another African swindle, had it not been for the discovery of Witwatersrand, which happened just at the moment when Barberton was at its lowest ebb. As early as January, 1884, Mr. Fred. Struben was busy prospecting on Witwatersrand for his elder brother, Mr. H. W. Struben, and a few months later he discovered the first conglomerate beds, to which at the time he did not attach very great importance, as his attention was naturally more directed to the quartz reefs, on one of which the Strubens erected their first five-stamp battery towards the end of the following year. Their enterprise in so doing undoubtedly entitles them to the credit of being the true pioneers of the most wonderful gold-field in the world. They crushed several samples of conglomerate, the best of which yielded only 8 dwts. to the ton, but some little time elapsed before the significance of the new formation they had discovered dawned upon them. It is not sufficiently known how little mere chance had to do with the discovery.‡ Mr. Struben had spent £11,000 on Witwatersrand alone before he made a single shilling. But he and his brother were old hands at the business. Mr. F. Struben had been one of the first prospectors in Lydenburg in 1872, and had subsequently roamed over the greater part of the Transvaal in search of gold and other minerals. In 1883, he prospected the Waterberg district, in the north-west of the Republic (which Mr. Struben considers a most promising gold-field), so that he had had twelve years of pretty varied experience, and had survived many disappointments before fortune finally smiled upon him on Witwatersrand. It was in the early part of 1886, that a servant of the Strubens, named Walker, while visiting the farm Langlaagte in that district, a couple of miles to the west of where Johannesburg now stands, discovered what is now known as the Main Reef Leader, and a few weeks later Mr. F. Struben and Mr. J. Bantjes struck the same reef on Vogelstruisfontein, a few miles further west. In July of that year, the first sample of conglomerate taken from the Bantjes Reef, was panned in Kimberley. Among those present at the panning was Mr. J. B. Robinson, who was so well satisfied with the prospects, that the very next day he set off for the Rand, and, leaving the Barberton coach at Potchefstroom, arrived by cart amongst the few miserable tents and shanties which were all that then formed the nucleus of what was destined to grow into the town of Johannesburg. By the 22nd of July, Mr. Robinson had completed his purchase of the Langlaagte Estate for the sum of £7000. The wiseacres thought him mad, and frankly told him he had paid £7000 for a cabbage farm. But he went on with his pannings, and in September secured a half share in the "Robinson" property for £1100, and two months later paid £12,000 for the other half. What follows is matter of history. The Langlaagte Estate and Gold Mining Company, floated with a capital of £450,000 on 2nd of January, 1888, has turned out £950,000 worth of gold in five years, and returned £330,780 in dividends to shareholders. The Robinson Company, with a present capital of £2,750,000, has produced over £1,400,000 worth of gold since its formation in 1888, and paid £570,937 10*s.* in dividends.* Not a bad return from properties costing originally £20,000.

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* Appendix XXXII.—De Kaap Output in 1892.

† Appendix XVI.—Gold in the Cape Colony.

‡ Appendix XI.—Mr. Struben on the Mineral Wealth of the Transvaal.

But these brilliant results were, of course, not immediately forthcoming. It seems that most new fields pass through at

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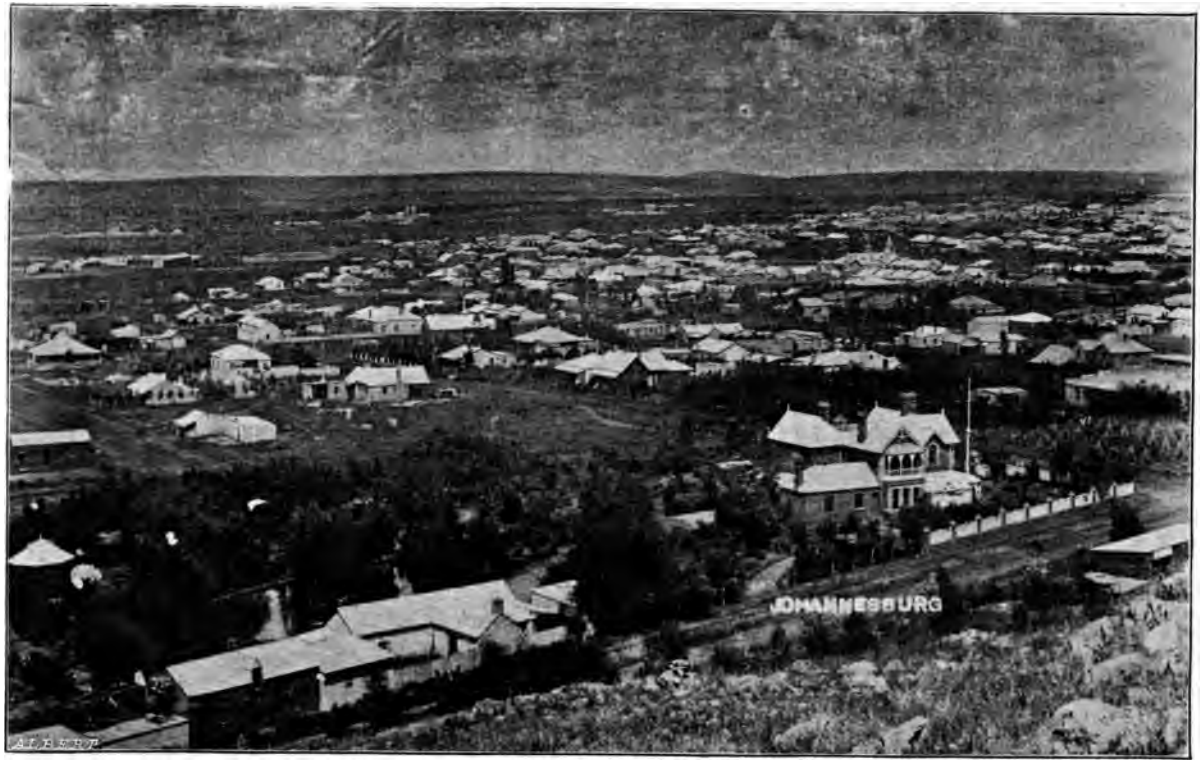
* From Fifth Annual Reports for the year ended 31st December, 1892.



PART OF JOHANNESBURG, FROM DOORNFONTEIN HILLS, 1893.

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least four stages before their position is firmly established. There is, first, the period of discovery, when no one believes in them, outside a small circle of enthusiasts. Then follow the first results, which are generally enormously overestimated, and speculation based on these exaggerated estimates leads to a reaction, and to a despondency as unreasonable as the previous expectation of gathering figs from thistles. Finally, when men have come to their senses, they recognise that solid work is the only sure foundation of success. No one acquainted with the manner in which the Witwatersrand mines are at present being worked will deny that directors have profited by the salutary lessons of the past, and are to-day honestly endeavouring to place their companies on a permanent dividend-paying basis. But before describing what has been actually achieved in this direction, it will be well to give a short sketch of the physical and geological features of the district, and of the manner in which the gold occurs, and is won.

Witwatersrand is the watershed of two great river-systems, the highest ridge of an extensive plateau, the High Veldt of the Transvaal, which stretches almost due east and west a distance of some 300 miles. On the north of the Rand all the streams flow into tributaries of the Limpopo, on the south into the Vaal, and thence into the Orange River. The town of Johannesburg, 26° 11′ 44″ S. lat., 28° 3′ 45″ E. long., situated 5735 feet above the sea,* is practically on the summit of this elevated land, which falls away rapidly towards the north, so rapidly that Pretoria, only thirty-five miles off, is 1600 feet lower. This gives Johannesburg its unique climate, and makes it, for its latitude, one of the coolest spots in South Africa. The winter is not more severe than in Kimberley, but the summer is delightful. In Kimberley there are often eight months of hot weather in the year; in Johannesburg barely four months, during which unbearably hot days are rare exceptions. There is a plentiful natural supply of water, and a fertile soil, in which trees grow with marvellous rapidity. Five years ago there was hardly a tree to be seen on the Rand, except surrounding the old homesteads; and now there are hundreds of gardens with green hedges, and in Doornfontein, and other suburbs, many of the roads vividly recall the country lanes of England; while extensive plantations are springing up in the outskirts in every direction, and in a few years will be most valuable forests of mining timber. In the summer time the whole veldt is carpeted with rich verdure, which the liberal rainfall keeps green and fresh for the greater part of the year. The volcanic agencies that have been at work, supplemented by a long period of denudation, have formed a succession of parallel ranges of hills, intersected by small valleys and ravines, each with its own little stream, where ferns grow profusely, so that the picnic resorts around Johannesburg are not without attractions to lovers of natural beauty.

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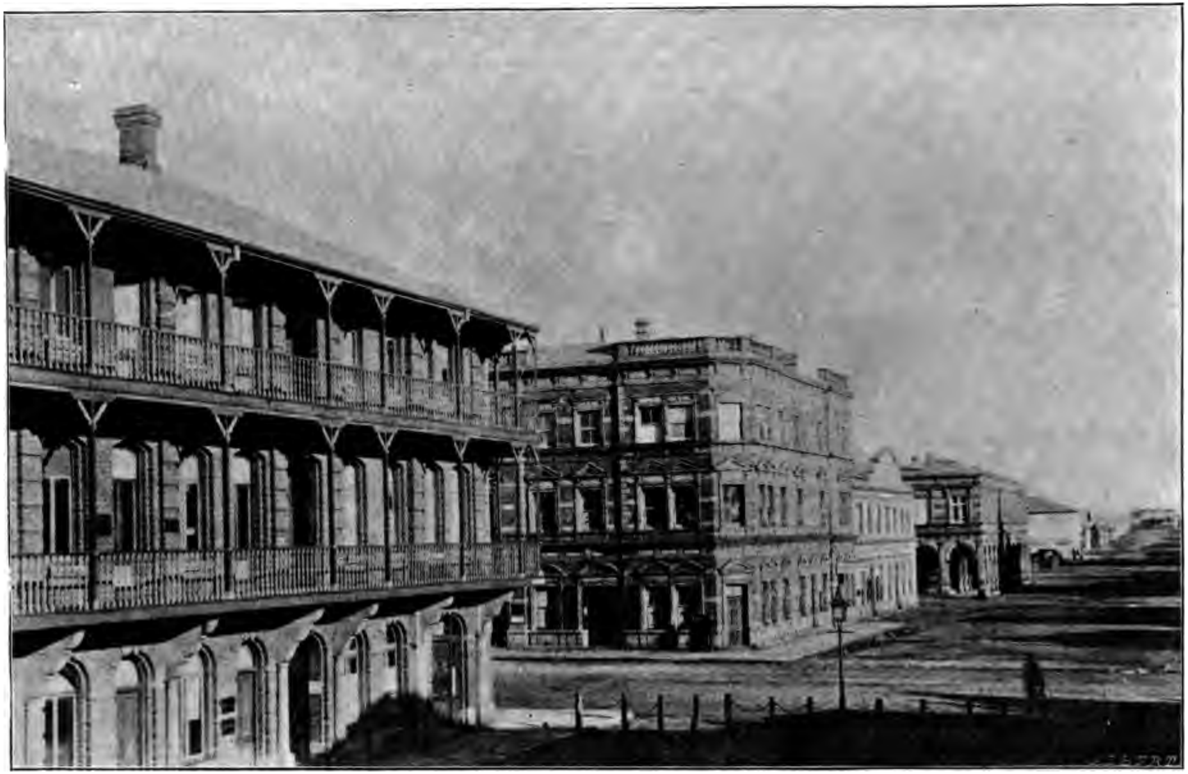
* "Mr. Edward H. V. Melville, the well-known Government Surveyor, has lately accurately determined the exact latitude and longitude of Johannesburg from a point which practically constitutes the exact centre of the town. The latitude, as determined by Talcott's method from fifty observations of double stars, was 26 degrees 11 minutes and 44·2 seconds. The longitude, one hour 52 minutes and 10 seconds, East, was determined by signals sent from Johannesburg to the Royal Observatory, Capetown, and *vice versâ*, Mr. Melville's astronomical hut being directly connected by telegraph with the Observatory. A Repsold Geodetic-Theodolite was used, an instrument of the finest possible make, costing some £300. The height of Johannesburg at the Park Station, as determined by the railway engineers, is 5735·7 English feet."—*The S. A. Mining Journal*, Johannesburg, 27th May, 1893.

Johannesburg cannot at present be called a beautiful town, though it is undoubtedly destined to become one of the finest cities in South Africa, and probably the largest. The business portion of the town will shortly consist of a solid mass of handsome double and three-storeyed buildings. The streets are being macadamised, and lighted with gas and electricity, and tramways extend from one end of the town to the other, a distance of three miles. There are fourteen or fifteen different suburbs, and though hundreds of houses are constantly in course of erection, the supply of dwelling accommodation does not keep pace with the demand. In the early days of the Diamond Fields people were content to live in wood-and-iron houses, showing their want of confidence in the future of the industry, or their intention of not permanently settling in the country. The residents of Johannesburg, on the other hand, are evidently well satisfied with their surroundings and prospects, as they have provided themselves from the outset with substantial,



SIMMONDS STREET, JOHANNESBURG, 1893.

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well-built houses, furnished in a European style of comfort. The shops compare favourably with any in South Africa, and are stocked with all the most modern wares and the latest fashions, and many of the large English makers of machinery and mining appliances have their own emporiums in the town. The population of Johannesburg, according to the Census taken early in 1892, was as follows:—

Adult Whites	10,137
Whites under 16	4,868
Natives (chiefly males)	6,710
Total Whites	15,005
Total Inhabitants	21,715

This is merely the population within the area controlled by the Sanitary Board, and does not include the mines, which in the immediate vicinity of Johannesburg (from the Langlaagte Estate on the west to the Metropolitan Company on the east) are estimated to contain 15,000 Europeans and natives together; nor does it comprise the residents in Doornfontein, estimated at 2000; nor the outlying suburbs of Booysens, Ophirton, Schweitzers, and Auckland Park, estimated at 1000—showing a grand total of 41,000 inhabitants, not including the mines westward of Langlaagte and eastward of the Metropolitan Company. The average number of labourers employed by the mines in 1892 was estimated at 2791 whites, and 25,858 natives; but the latter are now said to number 35,000.*

There are a number of rising townships situated along the line of the Main Reef, the most important of which at present are Boksburg on the east, and Krugersdorp on the west, connected by a light railway primarily constructed to supply the town and mines with coal. These two townships are each about 15 miles from Johannesburg, or about 30 miles apart; and from Boksburg, where the nearest collieries are situated, the railway is continued a further 10 miles to the more important coal mines at Brakpan and the Springs.† The main trunk line from the Cape is connected with this coal tramway at a place called Elandsfontein, about midway between Johannesburg and Boksburg, and proceeds from there direct to Pretoria, so that Johannesburg is not situated on the main-line of railway, but on a branch-line, which unnecessarily increases its distance from the coast-ports by nearly 20 miles, a cause of just complaint by its inhabitants, who are the chief customers of the railway. Under an agreement entered into between the Cape Colonial Government and the authorities at Pretoria, on the 10th December, 1891, the main trunk line from Bloemfontein has been completed to Viljoen's Drift on the southern bank of the Vaal, whence the extension to Pretoria has been constructed and is worked by the Netherlands South African Railway Company, the owners of one of the many mischievous monopolies, or concessions, with which the Republic is burdened. The same Company is building the railway from Delagoa Bay to Pretoria, which will pass through Middelburg and have a branch line to Barberton. It is at present only open from Lorenço Marques, on the east coast, to a few miles beyond Krokodilpoort on the boundary of the Portuguese territory,* and it will probably not be completed for some years to come. Until this event happens it is supposed that the Government will not sanction a railway connection with Natal, whose line has been completed to the border at Charlestown, a distance of 304 miles from Durban and about 135 miles from Johannesburg. The first railway communication between Johannesburg and the coast, *viâ* the Cape-Orange-Free-State line, was finished on the 8th September, 1892, and the first

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* See 'Witwatersrand Chamber of Mines Report for 1892,' pp. 106 and 21.

† "The proximity of large beds of coal to the Witwatersrand has proved of incalculable benefit in the development of the gold mining industry. Local coal has been supplied for local gold mining, and although the cost of fuel is

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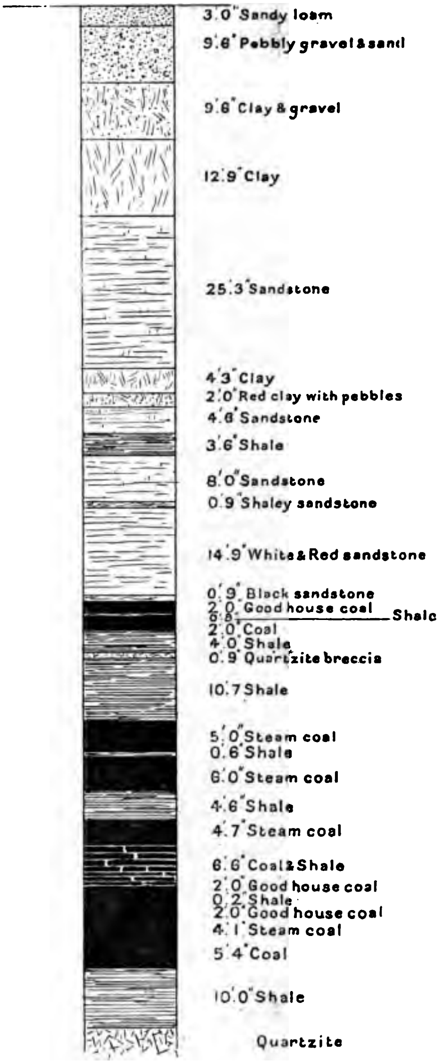
unduly increased by the heavy rate charged by the Netherlands Railway Company for transport, these fields have nevertheless an enormous advantage over the other districts which have either to use imported coal, or bring it from a distance within the State itself." The average cost of the coal delivered on the gold mines is from 10*s.* to 25*s.* a ton, according to the distance of the mine from the colliery, and the quality of the coal is from 50 to 70 per cent. of Welsh steam coal. The output of the Transvaal Coal Trust Company, Limited, during 1892 was 181,569 tons. This Company owns the Brakpan Colliery, and is by far the largest producer of coal in the Transvaal, giving over 60 per cent. of the total Rand consumption.—*Id.* p. 107.

* See map at end of volume.

Section of Strata at

GROOTVLEI SHAFT



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through train from the coast arrived at Johannesburg on the 15th, the through distances being as follows:—

From Capetown		1014 miles.
„ Port Elizabeth		714 „
„ East London		666 „

When the two eastern lines are completed, the distances will be:—

From Durban	about	440 miles.
„ Delagoa Bay	„	395 „

These figures speak for themselves, and though unfortunately at the present time the two English colonies are engaged in a war of tariffs in which both are impoverishing themselves for the benefit of a foreign State, it is evident that Delagoa Bay and Durban are the natural ports of the Transvaal, and that in the long-run the geographical position must assert itself.

The Transvaal gold-fields present many striking and novel features, interesting alike to the geologist and the practical miner. In the older gold-countries of the world, in Russia, America, and Australia, at least half the gold produced has been found in great *alluvial* deposits, and the remainder in *veins* traversing the mountain ranges, from which the alluvial gold has been derived. The conditions of the occurrence of gold in South Africa are very different. The amount of alluvial-gold hitherto produced in this country is so insignificant as to be hardly deserving of mention; and yet, in so large an area, which has been so little explored, it is impossible to say what mineral deposits may not be met with in the future. In these older mining-countries, the accidental discovery of large nuggets in the drifts and old river-beds led to the gold being traced to its source in the mountains. Here it is all very different. We have discovered no extensive alluvial fields, and what we call "Reefs" are not reefs in the usually accepted sense of the word. In the Barberton district, the most valuable mines are in *massive beds of quartzite,* carrying gold distributed in rich zones throughout a great body of rock. In the Lydenburg, and other districts, the gold is found in *thin bands of quartz,* interstratified with the shales and sandstones, and not cutting across the strike and dip of the strata, as is the common practice of the great gold-bearing fissure-veins of other countries. Finally, in the Johannesburg mines, and similar formations scattered at isolated points over South Africa, the gold occurs in *conglomerates* interbedded with sandstones and quartzites, and these, the most novel, if not unique, gold mines, are the most extensive and valuable deposits of gold as yet discovered in the country.

The broad lines of the *geology* of the Transvaal are sufficiently simple. The granite, which stands out so boldly at the Paarl, which strews the shore at Sea Point, and in many of the bays around the Cape Peninsula, and which forms the base of Table Mountain, probably extends as a basement through the whole of South Africa, but over the greater portion of that area it is covered by an immense thickness of sedimentary rocks, and it is only on approaching the Vaal river that the granite reappears at the surface. There is a great outcrop of granite immediately south of the Vaal, between Parys and Heilbron, in the Orange Free State; another outcrop between Johannesburg and Pretoria; and still further north, along the whole eastern frontier of the Transvaal, the granite constantly comes to light.* Resting immediately on the granite occur the principal gold-bearing rocks of South Africa, divided by geologists into a lower and a more recent series, both consisting more or less of quartzose strata, the upper series, being interstratified with beds of conglomerate. After these beds had been laid down,—horizontally, of course, by the currents of water which brought the constituents of the rocks from now unascertainable regions,—a great intrusion of igneous rocks took place, bursting through the granite, and tilting and dislocating the horizontal beds above, which were still probably covered by water. Then followed a long period of comparative calm, during which a further series of horizontal beds was deposited on the top of the tilted beds, culminating in the coal measures, the most recent of the existing sedimentary rocks of South Africa. "This period of deposition was probably attended with a still further inruption, or at least a movement, of the trappean rocks." Next occurred "a gradual upheaval of the whole system, accompanied by con-

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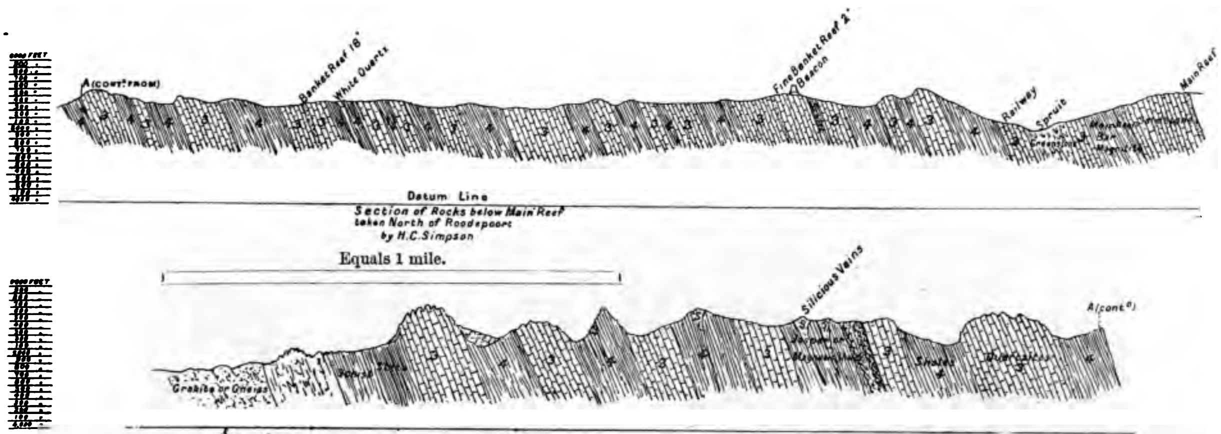
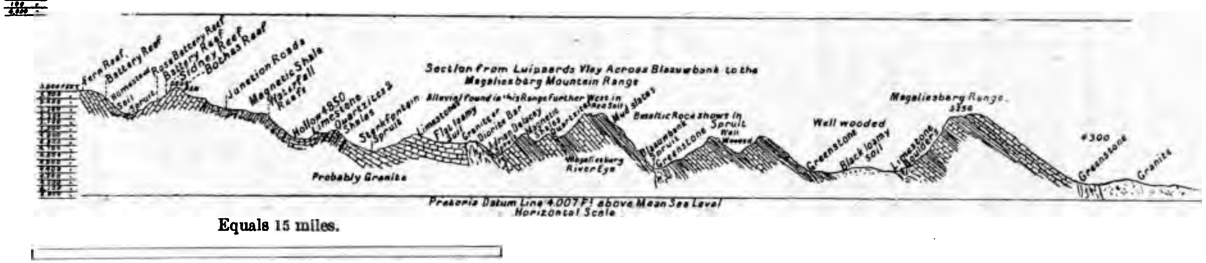
* See map at end of volume.





GEOLOGICAL SECTIONS NORTH OF JOHANNESBURG.

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siderable denudation, resulting in the exposure of parts of the lower series, and also of the intrusive igneous rocks, by the removal of the overlying strata. In the eastern parts of the country this upheaval apparently resulted in a very pronounced folding together of the lower strata, then probably in a pasty condition, and the entire removal of much of it, with the whole of the newer beds, from the surface of the granitic rocks below." Finally, we have to imagine "a very long extended period of subaerial denudation lasting to the present time, during which all the surface and alluvial deposits were laid down, and the land surface gradually assumed its present contour. This long sequence of geological action leaves us with the lower series of sand-beds mostly converted into quartzites, the clays into shales, schists, and flagstones, and the beds of pebbles into conglomerates." (*Alford,* on the Geological Features of the Transvaal, pp. 10, 11.)

The older quartzites are strongly developed around De Kaap valley, and it is in these rocks that the famous Sheba Mine is situated. The same formation covers a great portion of the Low Country, which is now attracting so much attention, owing to the active mining going on in the Silati and Letaba valleys, where the gold occurs in quartz reefs interbedded with the slaty rocks.* Quartz veins are also plentiful in the Kaap district, but they are generally the filling of surface fissures.

The sandstones, quartzites, and interbedded conglomerates of the High Veldt and Witwatersrand district, are met with again on the higher levels of the Kaap district, and in Swaziland, and across the border in Natal, and Zululand,† and the Free State,‡ as well as in the far north, in the Murchison Range, and the other hills of the Zoutpansberg district. The conglomerates usually carry gold, but it is only in the neighbourhood of Johannesburg, with very few exceptions, that they have been found to be payably auriferous; and it is notable that in this case they have been upturned and dislocated to a very marked degree, while in other parts of the country they are usually found almost in their normal horizontal position. In the Kaap district, the conglomerates are found capping the hills in small and isolated deposits, these being the remains of great masses of strata which have been removed by denudation.

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* Appendix XIII.—The Low Country Gold-fields.

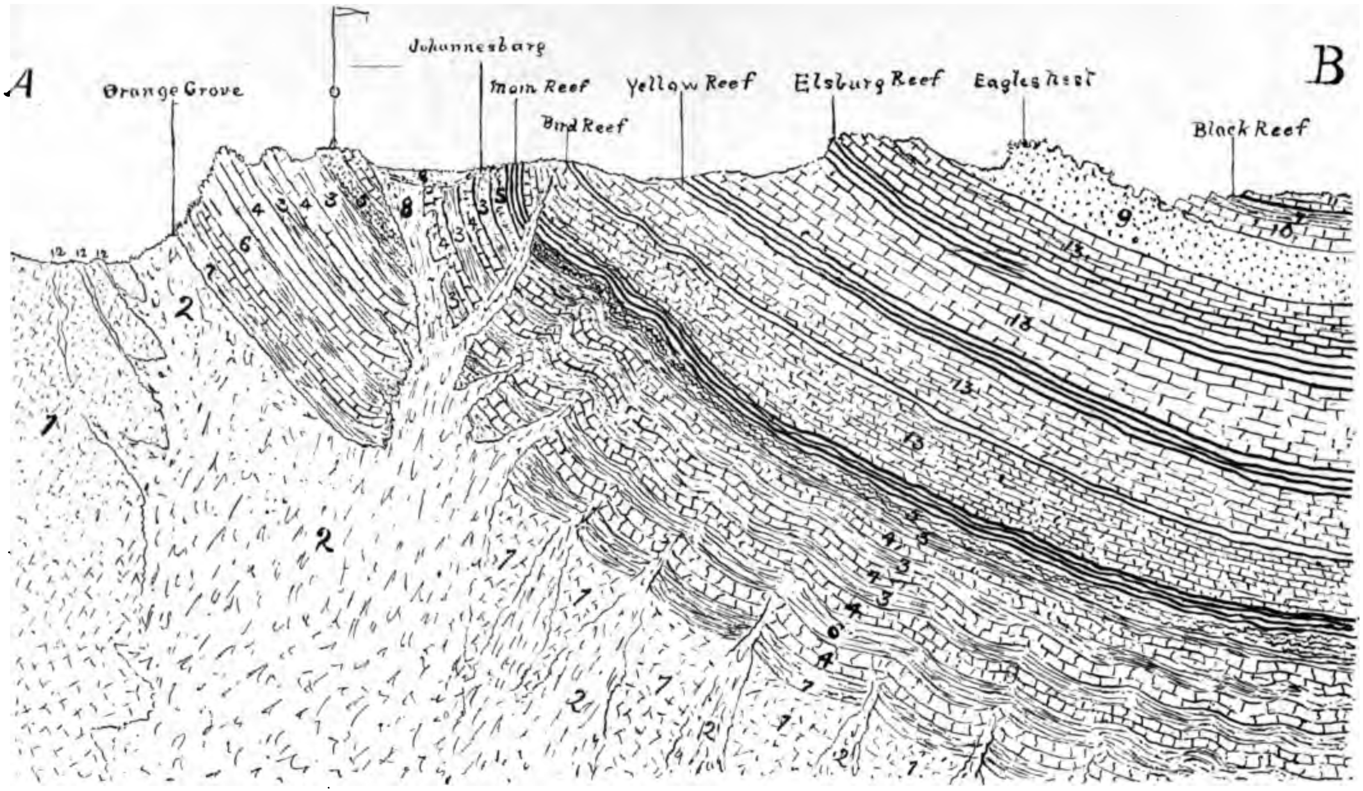
† Appendix XVIII. ‡ Appendix XVII.

Mr. Charles J. Alford, F.G.S., to whom I am indebted for most of the preceding geological notes, has been kind enough to furnish me with the following graphic description of the gold-bearing rocks around Johannesburg: "The general idea of the structure of the Witwatersrand gold-fields may be taken from that of a broken-up plate, of which all the various pieces retain in some degree the localities of their original deposition, but have been turned up, and in many cases thrust over each other in all directions. We may follow out the idea by assuming a quantity of molten sealing-wax to have been injected between the broken fragments of the plate, and the whole cooled and consolidated. Follow this up by a general smoothing down of the surface, and we shall have a very fair model of the district in question. The upturned edges of the broken pieces of the plate appearing at the surface would then represent the various reefs with their enclosing sandstones, while the sealing-wax takes the place of the intrusive igneous rocks."

And yet, though this is a true picture of the general formation of the country, the plate must be imagined magnified a millionfold to represent the Rand fields, so that the several broken pieces become rock masses of considerable dimensions. The outcrops of the reefs extend in a practically unbroken line, striking almost due east and west, for several miles on either side of Johannesburg, which stands on the northern edge of the principal, or *main reef*, and in about the centre of this long line of outcrop. It is hardly worth while enumerating the list of names which have been given to the several conglomerate beds, as it is certain that only a small number of them have as yet been discovered, and that the extent of the auriferous area cannot be calculated with the faintest approach to accuracy. What is known as the *Main Reef Series* comprises half-a-dozen parallel beds of conglomerate—locally called "*Banket*," from its resemblance to the sweetmeat known in English as "almond-rock"—the outcrops of which extend for twelve or fifteen miles on both sides of Johannesburg, and

DIAGRAM-SECTIONS ACROSS THE GOLD-BEARING BEDS OF THE SOUTHERN TRANSVAAL. By H. C. SIMPSON, A. of T.I. of M.A.M.L.

Fig. 1.—From Orange Grove through Johannesburg to Black Reef, 11 miles.



1. Granite or Gneiss; 2. Greenstone (Basaltic); 3. Shales; 4. Quartzites Sub-metamorphic Gold-bearing; 5. Jasper Shales, Magnetic; 6. Slates; 7. Schists; 8. Redsoil with boulders and detritus; 9. Amygdaloid Sheet; 10. Quartzites Black Reef Series; 11. Magnesium Limestone; 12. Quartz Veins Auriferous; 13. Quartzites M.R. Series A to ϕ 8,400 ft.; from ϕ to Main Reef, 6,950 ft.; there to Yellow R., 7,000 ft.; there to Elsburg R., 11,280 ft.; to E. N., 4,200; E. N. to Black Reef, 20,970 ft., or 58,800 ft. (Cape feet); ϕ is 5,780 ft., and B. 4,945 ft. above sea level.

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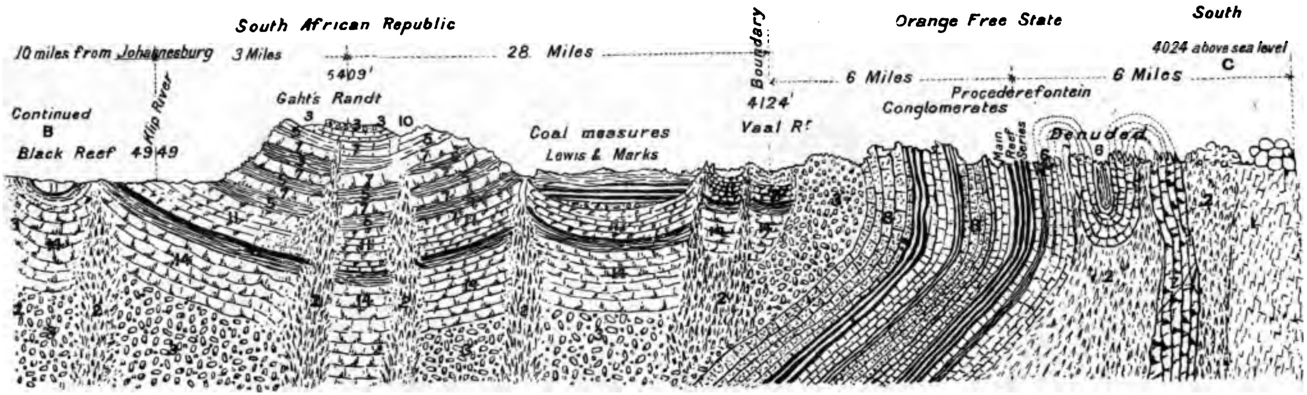
Fig. 2.—SOUTHERN SECTION OF WITWATERSRAND BASIN.



1. Granite; 2. Basaltic; 3. Dolerite (or Contemporaneous Sheets of Volcanic Mud, Amygdaloidal); 5. Slate; 6. Shale; 7. Quartzites; 8. Sandstones and Conglomerates 10. Magnetic Quartzite; 11. Limestone and Cherts; 14. Quartzites, Black Reef Series.

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trend then on both sides towards the south. The separate beds vary in thickness from a few inches to 20 or 30 feet, and the whole series from 40 or 50 to over 200 feet. They all dip towards the south at varying distances apart, and at varying angles from nearly vertical to nearly horizontal, and are repeatedly faulted and thrown out of line, but not to any very great extent so long as the east and west strike continues. Beyond these limits the disturbance is so considerable that the several reefs can no longer be followed, or identified with those of the Main Reef Series, but that their gold-bearing value is not necessarily impaired by this want of continuity is proved by the returns of such mines as the Chimes, Nigel, and Rietfontein, on the east, and the Champ d'Or and Randfontein, on the west. There are several other series of outcrops south of the Main Reef, the most important of which at present is the *Black Reef*, situated five or six miles south of Johannesburg, and dipping also towards the south, but at a very flat angle. On going still further south, the outcrop of the Black Reef is met with again, dipping this time towards the north.

Before reaching the village of Boksburg, some twelve or fifteen miles east of Johannesburg, the regular easterly strike of the Main Reef Series ceases, and, as already remarked, "the strata are broken up and thrown about in all directions, strike and dip altering completely every few hundred yards. There is, however, a distinct trending away of the outcrops towards the south, due, possibly, to the normal position of the edges of the basin-like deposits, but more probably to the direction of the axis of disturbance. The substructure of this part of the district is much obscured by surface deposits of detrital rocks, derived mostly from the disintegration of the reef series, and also by being overlaid by outliers of the upper series of rocks of the coal formation, by which, further to the eastward, the quartzite and conglomerate strata are completely covered, appearing only in small patches where the upper beds have been cut through by denuding forces. Under much the same conditions the same series of conglomerates and altered sandstones can be traced through, and to the eastward of, the town of Heidelberg, *for nearly sixty miles* south to the Vaal River, in the neighbourhood of which they disappear under the sands and clays of the coal formation. In places they have been removed by denudation, and the lower clay beds, or the intrusive trap rocks, appear at the surface; in others they are covered with masses of detrital matter, but the formation is distinctly recognisable over the whole area.

"To the westward of Johannesburg, also, after leaving the line of the Main Reef proper, the continuity of individual strata is lost or obscured, but the characteristics of the series can be followed past Krugersdorp, south-west to Potchefstroom and Klerksdorp, a distance of about *one hundred miles.* The conglomerates appear to be very generally auriferous all along the line in a greater or less degree." "The country south of Johannesburg to the Vaal River is much broken up by repeated intrusions of trap rocks, and covered by deep deposits of drift and detritus, the granite appearing occasionally in the beds of the streams where the overlying strata have been cut through and removed." (*Alford,* Geological Features, pp. 23–25.)

"Turning north from Johannesburg and crossing the ridge of hills of the Witwatersrand, on the road to Pretoria, the geological formations of the district are passed in a descending scale—first the stratified quartzites, and then the shales, schists and flagstones, until the granite appears from under them at the Yokeskey Spruit."

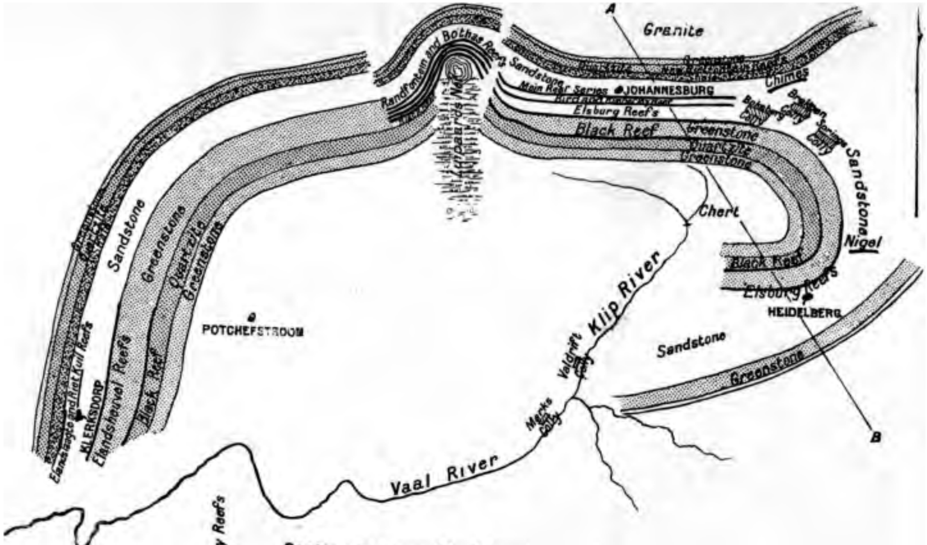
"In the granite rocks occur mineral deposits entirely different from those hitherto noticed, and which may be classed as follows:

(*a*) Surface fissures in the granite, filled with quartz, which is often to some extent auriferous near the surface, but extends to no great depth.

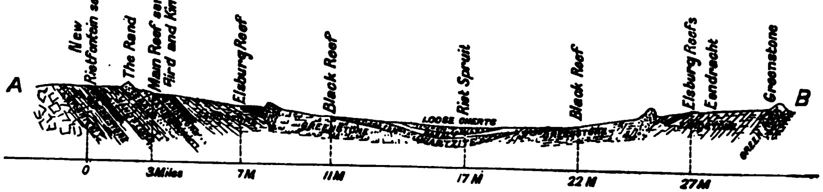
(*b*) True fissure-veins, usually faults in the granitic rocks not terminable in depth, and carrying, as far as has yet been ascertained, *argentiferous copper* and lead, with antimony and many other minerals, but little or no gold.

"The first class are of little value as workable deposits,"—it was in these that the first discoveries of gold on Witwaters-

Geological Chart of the Witwatersrand Basin



Section across the Rand between Elandsfontein and Eendracht



[Reproduced, with permission, from Mr. F. Spencer's contribution to the 'Official Handbook of the Cape and South Africa.']

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rand were made, and they have therefore considerable historical interest,*—"the yield of gold and extent of deposit being both, as a rule, very limited. The second are a class of deposits the importance of which it is hardly possible to estimate until they have been worked upon to a far greater extent than at present, but their possibilities may be almost anything." (*Alford*, pp. 29, 30.)

The Transvaal Silver Mines, the Albert Mine, and the Willows Silver Mine are situated in this second class of deposits, in the Pretoria and Middelburg districts.†

Returning to the Rand gold-fields, it will be noticed that the outcrop of what is probably the Main Reef Series has been traced from the Vaal River north through Klerksdorp and Potchefstroom to Krugersdorp and Johannesburg, and thence through Boksburg and Heidelberg south to the Vaal River again, a distance of *over one hundred and fifty miles.* There are also the other series of reefs running parallel to, and both north and south of, the Main Reef proper, of which as yet but very little is known, though they have been proved in several instances to be highly auriferous, as in the case of more than one property on the Black Reef, and also on the Rietfontein Estate, which lies about three miles north of the Main Reef, and some eight miles east of Johannesburg. What the ultimate payable extent of this marvellous gold-field may prove to be, it is impossible to predict, but it is safe to say that it certainly covers *several hundred square miles* of country, that it contains vast deposits of mineral wealth which many generations will not exhaust, and that, in a word, it is, by far and away, the most valuable gold-field in the world.

Having defined the locality and approximate extent of the Rand fields, we must now confine ourselves to that comparatively small portion of it at present being actively worked. This portion extends from Randfontein on the west to Heidelberg on the east, a distance of some fifty miles, though, as has been already explained, between the latter town and the neighbourhood of Boksburg there is a stretch of about fifteen miles over which the gold-bearing formation is overlaid by outliers of the coal measures.

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* Appendix XI.—Mr. Struben on the Mineral Wealth of the Transvaal.

† Appendix XXII.—The Transvaal Silver Mines.

Between Randfontein and Boksburg, a distance of over thirty miles, there is an absolutely unbroken succession of mines, most of them in full swing, and it may confidently be asserted that there is no such sight to be seen anywhere else in the world. The pithead-gears, which mark the strike of the reefs, rise in regular order every few hundred yards, and the whole country is studded with the batteries and other surface-works representing several millions of capital expenditure.

It will naturally be asked, What evidence is there of the continuance of the reefs in depth? They have been actually proved by boreholes to a depth of 2400 feet, and by the deepest shafts to a depth of 700 feet vertical, and 1000 feet along the line of "dip." But, as it is perfectly certain that the conglomerate beds were originally deposited horizontally, and as the outcrops of their upturned edges have been traced for a length of over 150 miles, it is impossible to conceive that the area of their deposition should not have had a breadth in some degree corresponding to its length; and, as a matter of fact, the same series of beds is found outcropping south of the Vaal River, in the Free State, but this time dipping towards the north.* On the eastern and western extremities of the reef the beds dip towards the centre. It has therefore become natural, with these facts before us, to speak of the Witwatersrand gold-field as a vast *basin* of auriferous reefs, the rim of which, exposed by the upturned edges on the north, east, west, and south, dips everywhere towards the centre.

The five or six parallel beds of conglomerate, which form what is known as the Main Reef Series, differ very much, in their lateral extent, in distance apart, angle of dip, thickness, and richness. The thickest reefs are invariably the poorest, and the richest reefs are often, but by no means generally, the most vertical at the surface. All have a distinct tendency to flatten in dip as depth is attained, but no forecast can be made of the rate at which this will happen in any particular mine. In the immediate neighbourhood of Johannesburg, in the Jubilee, Salisbury, Wemmer and Ferreira mines, the reefs are almost vertical at the surface, the average dip being from 75 to 80 degrees with the horizon, and these reefs, as is well known, are some of the richest on the Rand. For a couple of miles further west, however, in the Robinson, Crown Reef, and Langlaagte mines, the average dip is not much over 45 degrees, and yet these mines are, on the average, even richer than the last named. On leaving Johannesburg, both on the east and west, the reefs become flatter, the average dip being about 45 degrees, rising in parts of some mines to over 60 degrees, and again in others flattening to about 15 degrees at the surface. This proves pretty clearly the correctness of Mr. Alford's image of the broken-up plate.

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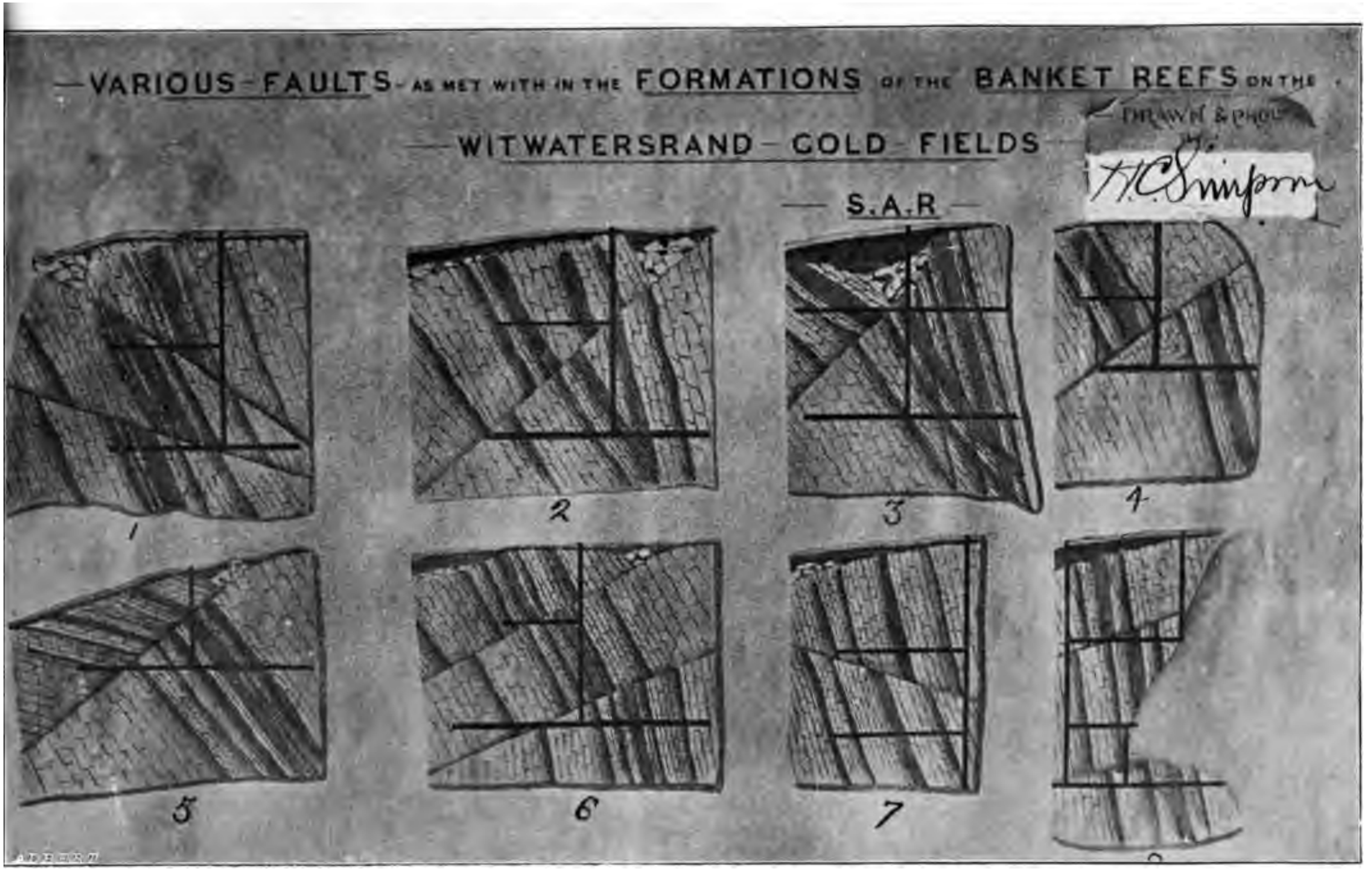
* Appendix XVII.—Gold in the Orange Free State.

The following is a list of the "banket" beds of the Main Reef Series at present being worked:—

Name of Reef.	Thickness.	Distance apart.	Grade.
North Reef . . .	1 foot to 5 feet.	20 feet to 100 feet.	Trace to 1½ oz.
Main Reef . . .	4 feet to 40 feet.	Few inches.	Trace to 1 oz.
Main Reef Leader .	6 inches to 6 feet.	Few feet.	½ oz. to 10 oz.
Middle Reef . . .	6 inches to 4 feet.	20 feet to 150 feet.	Trace to 1 oz.
South Reef . . .	1 foot to 6 feet.		½ oz. to 50 oz.

The outside beds are occasionally each split up into two separate reefs, known respectively as No. 1 and No. 2 North and South Reefs, and on some properties a few miles to the west of Johannesburg there is a further reef to the south of the South Reef, known as the *Red Reef*. The whole series of these six or eight reefs is by no means continuous along the line of outcrop, and their relative distance apart alters continually along the line of strike. They vary also constantly in thickness and in grade. The width across the whole series varies in different properties from under 100 feet to over 300 feet. The *North Reef* is generally poor, but is mined at a profit on several properties. The *Main Reef*, as its name implies, is the largest of all the deposits, and though it is little worked on at present, it undoubtedly contains a vast body of auriferous ore (averaging in places 6 to 8 dwts. per ton), to which attention will certainly be directed in the future. The *Middle Reef* is frequently mined to advantage in conjunction with its adjacent reefs. But the most important of all the deposits are the *Main Reef Leader*, and the *South Reef*, from which up to the present nearly all the gold produced has been extracted. These two beds, though small in comparison with the other reefs, are still very considerable and persistent bodies of ore, averaging from one to two feet in thickness, and carrying gold in payable quantities along the whole length of the Rand, say for twenty miles in an almost unbroken line. They are, therefore, probably the most valuable gold-reefs as yet known to exist in the world. In the Robinson mine, the Main Reef Leader, Middle and South Reefs, mined together, have yielded an average of 2 oz. of gold per ton of rock.

The conglomerate beds, or banket-reefs, are composed of a mass of rounded quartz pebbles set in a hard cement, or matrix, of highly ferruginous quartzose matter. The pebbles vary in size from less than that of a pea to exceeding the size of a hen's egg, and in colour from white to dark grey, with many variegated shades. The several reefs can generally be identified by the size, number, and colour of the pebbles. The gold occurs chiefly, if not almost exclusively, in the cement, and to a large extent on the surfaces of the pebbles and in the cavities of the matrix in which they are embedded. "It appears certain that the gold was not transported to its present position, in the form of native gold, by water; its origin is a curious and interesting problem. As has been already remarked, the deposits in question are by no means uniformly auriferous individually, nor are many of the beds auriferous at all. Many deposits have been found to be exceedingly rich in places, whilst others, and other parts of the same bed, are barren. It will be readily understood that where the edges of the beds are exposed at the surface, and a long period of quiet denudation has supervened, the outcrops will have become abnormally enriched by a process of geological concentration. But there is more than this to be noticed, as rich portions of the deposits appear to occur, in


—VARIOUS-FAULTS-AS MET WITH IN THE FORMATIONS OF THE BANKET REEFS ON THE
—WITWATERSRAND-GOLD-FIELDS—
—S.A.R—
DRAWN & PHOT. BY
H. C. Simpson
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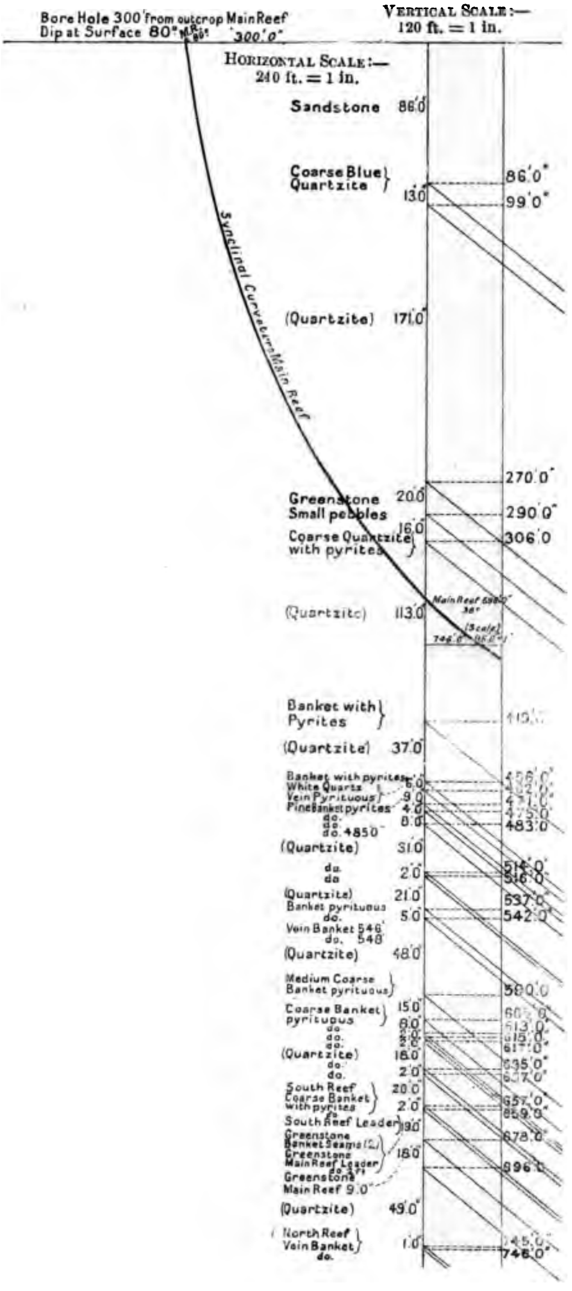
which no structural or other difference can be detected from any other part, rather in the nature of zones than pockets or ore shoots, and to bear some regular relation to the position of the bed and the proximity of the intrusive rocks. It appears that adjacent to the more disturbed parts of the ground these zones of auriferous matter are more than usually marked, and where the beds stand vertical, or with a high angle of dip, they appear to go down somewhat in a perpendicular direction. There appears to be some analogy between these auriferous bands and those noticeable in the auriferous compact quartzites of the Barberton district." (*Alford*, p. 28.)

There is a great difference in the relative hardness of the rock in different mines on the Rand, often in adjoining properties, and, as is well known, a great difference also in the richness of the ore. Till the water-level is reached, at distances varying from 50 to 150 feet from the surface, the encasing rock is soft red sandstone, and the conglomerate of the same colour and correspondingly easy to mine. But below the water-level a great change takes place. The sandstone alters to hard blue quartzite, and the conglomerate to a tough pyritic ore requiring the use of machine drills for its extraction. The bedding also becomes less clearly defined, making it often difficult to distinguish the conglomerate from the country rock. More important is the change in the occurrence of the gold itself, which, from having been mainly "*free*" above the water-level, becomes intimately, though not chemically, associated with sulphides of iron below that level, so that more elaborate processes are necessary for its recovery. The *pyritic ore*, however, is not less rich in gold than the free-milling ore above it.

As has been already remarked, the strike of the reefs is almost due east and west for 12 or 15 miles on either side of Johannesburg, but along the whole of this distance there are constant breaks, or "*faults*," in the reefs, which throw them, from a few feet to several hundred feet, north or south of the line of strike, sometimes accompanied by dykes of *diorite* (generally almost vertical intrusions of igneous rocks), which at other times cut through the beds without throwing them out of line. These dykes are of all sizes up to several hundred feet in thickness, and often cut out a considerable area of claim-ground.

The size of a "*claim*" in Johannesburg is 150 Cape feet measured along the strike, by 400 feet measured across the dip, or slightly over 64,000 English square feet of surface measurement, so that one claim is about 1½ acres. Thirteen cubic feet of solid "banket" are usually taken as equal to one ton (of 2000 lbs.). This results in a simple rule for calculating the amount of ore in a mine, as follows: For every foot in depth along the dip, and every inch in thickness of the reef, there is *one ton of ore per claim.* Naturally, the total amount of ore in a mine depends very much on the angle of dip; with a reef only one foot thick, dipping at 85 degrees with the horizon, and outcropping exactly on the northern boundary of the property, there would be as much as 56,500 tons of ore in a single claim, *assuming the angle of dip to remain unchanged* till the reef runs out of the claim at its southern boundary; with a dip of 30 degrees there would be only 5700 tons of ore in the claim. Did the steeper angle continue uniform, a depth of 4750 feet would be reached before the claim was exhausted. The actual conditions, however, are very different from these. On one part of the Rand, where the reefs at the outcrop dip at 80 degrees, a borehole was put down 300 feet south of the outcrop and struck the same reef at a depth of only 696 feet below the surface, at which depth the dip was found to have flattened to 38 degrees. Had the original dip remained unchanged, a depth of 1700 feet would have had to be sunk to, before striking the reef.

The discovery of this flattening tendency in the reefs led to the formation of the so-called *Deep Level Companies* to acquire the claims to the south of those originally pegged out along the outcrop. The far-seeing companies on the outcrop acquired their own *dip claims*, thus insuring an indefinite lifetime for their properties. Those not so wise will either work out their mines within a measurable period, or will have to make terms with the holders of the dip ground. But considering the Fields as a whole, this flattening of the reefs in depth is an immense advantage, since it vastly increases the *area* of auriferous ground over which profitable mining will be possible.



HENRY NOURSE DEEP LEVEL BORE HOLE.

To face page 102.

No limit can as yet be assigned to the depth at which metalliferous mining is practicable. The great Comstock Lode, in Nevada, is now being worked at a depth of over 3000 feet, and other silver lodes in South America have reached about the same depth. There is no mechanical difficulty about deep mining, and the extra cost is not a serious consideration, when adequate hoisting and pumping machinery have once been provided. The greatest obstacle is defective ventilation; yet, the famous Dolcoath mine in Cornwall, which is now nearly 3000 feet deep, is actually found to be cooler at that level than it has been any time within the last five-and-twenty years. Without attempting to estimate the fabulous quantity of ore that will be "in sight" in the Johannesburg Main Reef Series before this depth is attained, some idea may be formed of the practically inexhaustible store of gold which these reefs contain. They have been exposed along the outcrop for at least thirty miles, and we may assume they will be within reach of mining operations for probably several miles across the dip. Let us fix the limit at only one mile, and we have 30 square miles of auriferous beds under our feet. Of the two or three hundred feet which these beds measure in thickness, allow only five feet to carry gold in payable quantities. According to the last returns of the Witwatersrand Chamber of Mines, the average yield of the district is at present 10 dwts. of gold per ton of ore crushed.* It is known that a good deal of gold is lost which more perfect treatment will enable to be saved in the future, but we will take a low estimate and assume those five feet of payable "banket" to carry an extractible average of only 8 dwts. per ton. Then, unless our multiplication is at fault, we arrive at 130,000,000 *ozs. of gold*, worth, say, £450,000,000, as the value of the ore locked in Nature's treasury, and only waiting the industry of man for its extraction.†

How exceedingly modest this estimate is may be judged from the large allowances made for contingencies, but the fact becomes more evident when we remember that in the foregoing calculation no account is taken of the rich deposits actually being worked beyond the limits of the 30 miles line of strike, at the Nigel and at Randfontein, nor of the other parallel series of beds to the north and south of the Main Reef Series, as yet but little explored, but the possibilities of which are proved by the recent rich discoveries on Rietfontein and the Black Reef.

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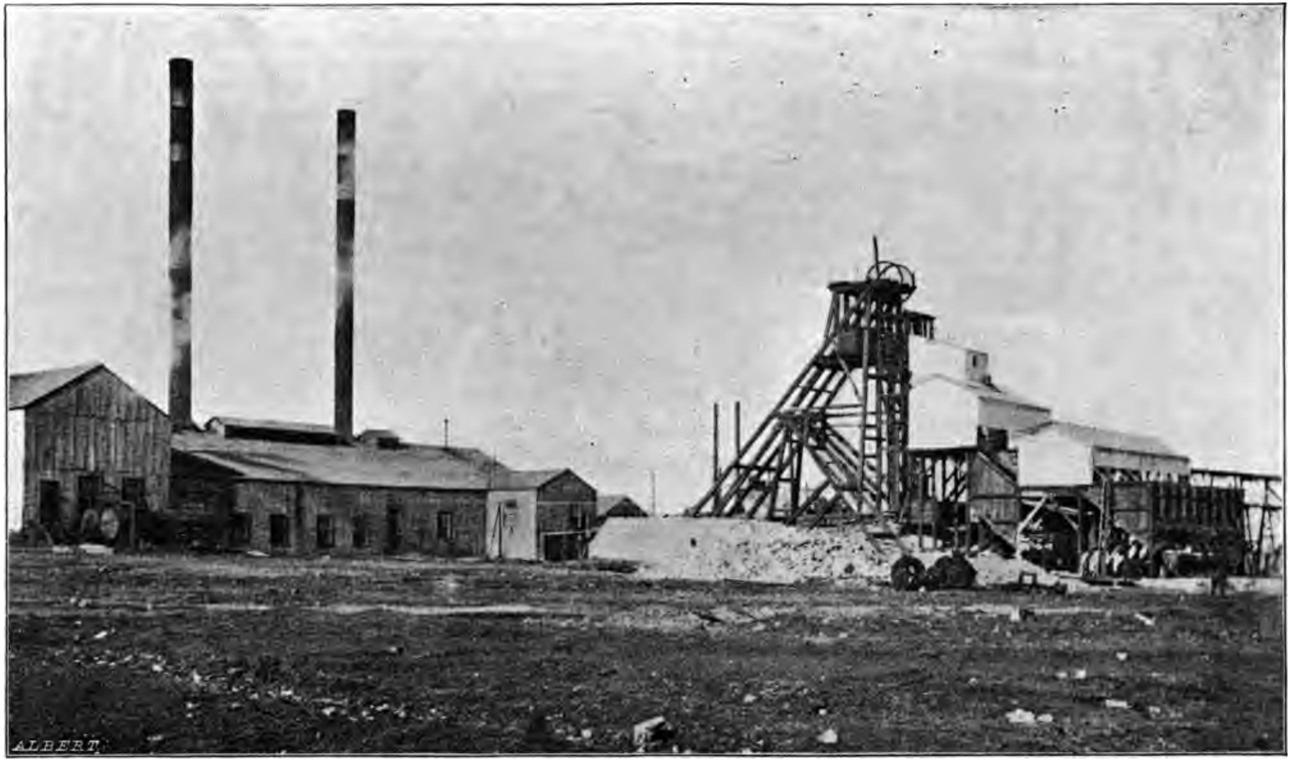
* This is merely the yield from the mill; but subsequent treatment, by cyanide and other processes, brings up the total average yield to over 12½ dwts. per ton. See Appendix XXVIII.

† Appendix XIX.—Mr. Hamilton Smith, by a different method of calculation, arrives at much the same result.

Having described the extent and formation of the Rand fields, a brief account will now be given of the manner in which the mines are worked; and as this does not differ materially from the mining and metallurgical operations in other gold-countries, no very detailed explanations will be necessary.

In the early days of the fields, before the great depth of the conglomerate beds had been established, the mining was conducted by digging open trenches along the outcrops of the reefs, and sinking small inclined shafts to follow the "dip." This primitive system of work was soon discarded in favour of vertical shafts sunk at a convenient distance south of the outcrops, so as to cut the various parallel reefs, or of main inclined shafts fitted with skips similar to those used in Kimberley. At a depth of two or three hundred feet, the vertical shafts are frequently converted into inclined, or "underlay," shafts, to avoid the expense of cross-cutting to strike the reefs. The shafts are 12 or 15 feet long by 5 or 6 feet wide, and are divided into three compartments for two skips, or cages, and a pumpway. The winding engines are fitted with loose drums and clutches to enable two different levels to be hauled from at once. There is a good deal of water in most of the mines, which are generally drained by Cornish pumps driven by separate engines on the surface. As the shaft goes down working levels are opened up, generally about 100 feet apart on the line of dip, and provision is made for ventilation by small shafts, or winzes, sunk from the level above or from the surface. On a large property two or more main shafts are required, usually 300 or 400 yards apart on the line of reef. At each working level a main cross-cut is



FERRAIRA MAIN SHAFT HEAD GEAR, ETC.

To face page 104

driven north or south from the shaft to intersect the reefs at right-angles, which are then driven along east and west to the boundaries of the property. While the ore is being extracted from one level, other levels are being opened up lower down. The work of opening-up is known as *development*, the work of extraction as *stoping*.

The surface works necessary for winning the gold from the ore are of an elaborate and costly nature, and the profitable working of the mine depends largely on the wisdom and skill with which they are designed and constructed. The process of gold-extraction consists of two stages, the reduction of the ore to a fine pulp or powder, followed by various mechanical and chemical operations for separating the precious metal from the "gangue" or worthless constituents of the rock. The ore raised from the mine is first broken in a Blake, or other, crusher to cubes of about one inch, and is then pulverized in the mill to any required degree of fineness. The Californian stamp mill, which derives its name from the country where it was first introduced forty years ago, has held its own against the best of crushers and pulverizers which have since been invented, and is the only form of mill used on the Rand. It consists of a massive timber frame carrying a horizontal shaft with revolving double cams, each of which raises a vertical steel stem 6 or 8 inches high twice every revolution, and allows it to fall by gravity into the cast-iron mortar-box in which the ore is pounded till it is fine enough to pass through the wire screen which forms the only means of outlet. The lower end of the stem is shod with a steel shoe, and the ore is crushed between the flat surfaces of the shoe and the stationary steel die in the mortar-box. There are five stamps to each mortar-box, forming one battery, and a mill is therefore always some multiple of five stamps, the largest at present working on the Rand being the 120-stamp mill at the Langlaagte Estate.* The falling weight of a single stamp varies from 700 lbs. to 950 lbs. each, including the weight of the stem with its tappet, head and shoe, and the best results are got from the heavier stamps. Each time the cam strikes the tappet, it gives the stamp a slight twist, thus equalising the wear, which is practically confined to the shoe and die, and it is this feature of great durability in the Californian mill which renders it so superior to all the mechanical contrivances by which it has been sought to supersede it. The cam-shaft makes about 45 revolutions per minute, giving 90 drops to each stamp, so that in a 100-stamp mill there are 9000 drops per minute, and some idea may be formed, by those who have not heard it, of what the noise is like. Conversation in a battery-house is practically impossible. There are now 2000 stamps in regular work on the Rand; the sound of their useful thunder, beating out the means by which we live, may be heard for many miles, and at night there is a music in it strongly resembling the roar of breakers on the sea-shore.

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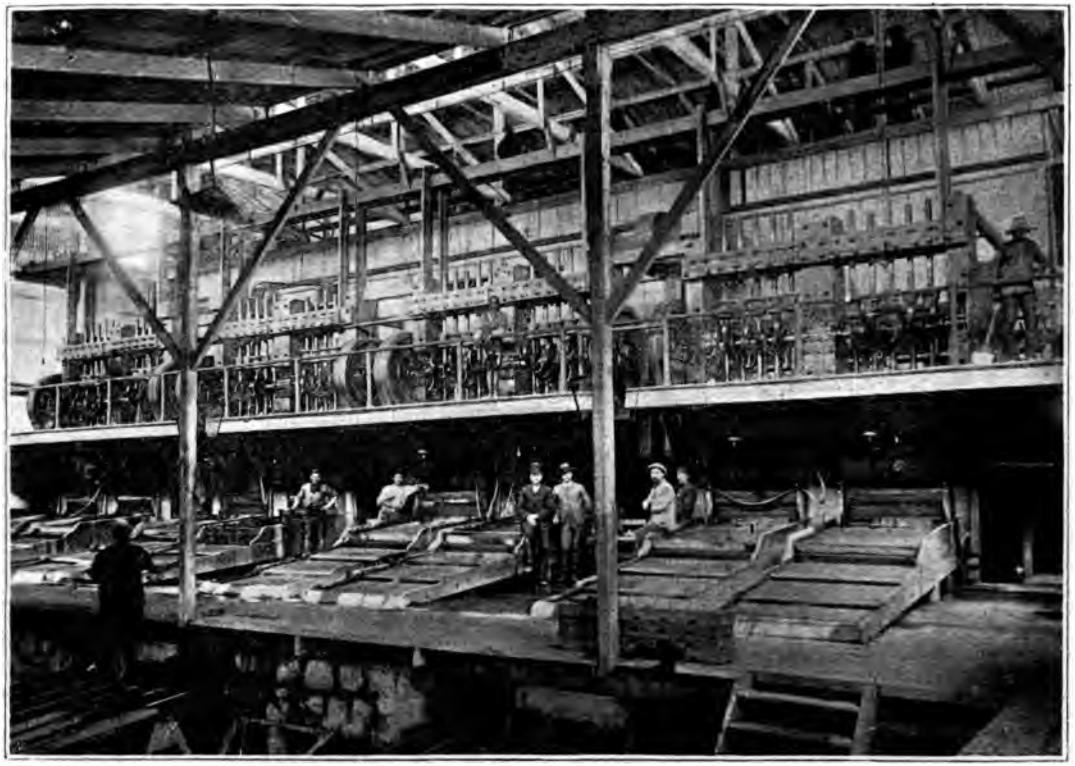
* Still larger mills are under order and in contemplation.

In a well-designed mill, the ore trammed from the mine is dumped onto *grizzlies*, or strong inclined gratings, on the top floor of the mill, and after that requires no further handling. The coarse lumps pass to the Blake *crushers*, the product from which falls into the *ore bins* together with the finer stuff which has passed through the bars of the grizzlies. The object of the bins is to afford sufficient storage of crushed ore to avoid any stoppage of the mill in the event of the supply from the mine being temporarily interrupted. Many engineers now prefer to place the bins immediately at the shaft-heads, and to erect the crushers also at the mine, which materially reduces the height and consequent expense of the mill, and also enables the rock to be carefully sorted when it reaches the surface. The crushed ore at the mill is drawn off by *automatic feeders* and delivered in regular quantities to the mortar-boxes. There are two kinds of stamp mills, wet and dry, but the wet mill is the only one in use on the Rand. It is not improbable, however, that some form of dry crusher may find acceptance, if the proposal to treat the ore direct from the stamps by the cyanide process (to which reference will presently be made) should prove a success. Water is fed into the mortar-boxes where the ore is reduced to a pulp, splashing against the wire screen through which it passes onto the inclined *tables* in front. The *reduction of the ore* is now complete, and the work of *collecting the gold* commences. The mesh of the screen



ROBINSON COMPANY'S BATTERY.

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depends on the richness and character of the ore to be treated, and of course determines the amount of ore crushed in a given time. The common practice on the Rand is to use a screen of 900 holes to the square inch. The product varies, according to the mesh and the weight and general construction of the stamps, from two to five tons of ore crushed per stamp per day of twenty-four hours. The average of 2000 stamps in July, 1892, was three and a quarter tons per day. It is now somewhat higher.*

The tables are covered with silvered *copper plates* about six feet wide, and eight or ten feet long (in front of each mortar-box), and the plates are soaked with mercury, which has the useful property of clinging hold of any particles of gold it comes into contact with. Similar plates are also inserted on the sides of the mortar boxes, where a considerable portion of the free gold is collected, a quantity of liquid mercury being also poured in. This process of gold winning is known as inside amalgamation. The pulp from the tables passes in some mills through *mercury troughs* (a simple form of amalgamator which causes the particles of crushed ore to come into direct contact with the quicksilver), and thence over *blanket strakes*, which are the simplest form of concentrators. The *tailings* from the strakes either run to waste, or, more generally, are collected in settling-pits for subsequent treatment.

The mills run day and night, weekdays and Sundays, without ceasing, a simple arrangement enabling each stamp to be hung up separately for examination or repairs without stopping the others. At intervals, depending on the richness of the ore, the plates are scraped, and the batteries are stopped one at a time, to remove the *gold amalgam*. This is known as the *clean-up*. The blankets are periodically taken up and washed to secure the *concentrates*. On several occasions a number of mechanical *amalgamators* have been introduced at various mines, the object of which is to bring the gold into more intimate contact with the mercury than is supposed to be done on the plates, but in nearly every case these machines have been discarded after a brief trial as not being worth the money it costs to work them. When sufficient amalgam has accumulated it is *retorted* to separate the gold from the quicksilver. The retort containing the amalgam is closed by an air-tight cover fitted with a vent, and is placed in a furnace, where it is heated to above the boiling-point of mercury, which passes through a pipe in the form of vapour to the condenser, where it is cooled and liquefied and rebottled for subsequent use in the mill. With ordinary care there is very little loss of mercury in all the stages of transformation which it undergoes. The gold collected in the retort is melted in crucibles and poured into moulds lettered with the name of the mine, and is then known as *bullion*, ready for sale to the banks.

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* See Appendix XXVIII., which gives the total average for 1892 as 3·21 tons, but shows an increase of more than one ton per stamp between January and December of that year.

For the first two or three years after the opening of the Rand fields all the ore mined was free-milling, yielding the bulk of its gold by the simple process of amalgamation described above, and a great number of the mines are still only working this free-milling rock. But as the pyritic ore is reached much more complicated processes are necessary, which, though involving a considerable outlay in additional plant and machinery, allow of a far greater percentage of gold being saved than is possible by simple plate-amalgamation, and, if proper methods are adopted, result in much larger profits. It is no disadvantage, therefore, for a company to have exhausted its free-milling ore, but quite the reverse. The work of gold extraction is greatly facilitated and simplified by the fact that the pyritic ore of the Rand is very different from what are called *rebellious ores* in other countries, where they often contain arsenic and antimony in addition to the iron pyrites, which is the only base metal to be reckoned with in the Banket ores. The preliminary treatment of pyritic ores is the same as for free-milling, but as only about half the gold in the rock is saved by amalgamation, subsequent treatment is necessary to recover the balance.

The usual practice in most countries is to deliver the tailings direct from the copper plates to some form of concentrators, of which the *vanner* is the one most extensively employed, and which serve the purpose of greatly reducing the bulk of stuff to be treated, while separating the heavy constituents of the ore, including the gold, from the lighter sands which flow off as tailings. This is the *theory* of the vanner, but in present practice only a small proportion of the gold is actually saved in the form of *concentrates*, so that the *tailings* from the vanners have to undergo still further treatment.

The *concentrates* from the vanners are treated by the *chlorination*, or Plattner, process. The only mine on the Rand at present possessing chlorination works is the Robinson Company, who, in addition to treating their own concentrates, purchase the concentrates from other companies and treat them at their own risk. The first section of these works, which are situated in separate buildings at some distance from the mill, was completed in the latter part of 1891, and in the last four months of that year the company produced 7982 ounces of fine gold from their own concentrates, and subsequently enlarged the works to deal with the large parcels of concentrates offered for sale by other companies, which are bought by weight and assay, and are delivered in sacks to the receiving-house at one end of the building, whence they are drawn on elevated tram-lines and dumped into the storing and drying-house and mixed with the company's own concentrates coming from the mill. The chlorination works have two departments, in which the *roasting* and *chlorinating* are conducted in separate buildings, known as furnace-house and tank-house. The furnace-house contains three *long-hearth reverberatory furnaces*, the hearths having been modelled after the Alaska Treadwell type by the Company's former metallurgist, Mr. C. F. Butters, and have special fireboxes designed to burn Transvaal coal. Connected with this furnace is a series of dust chambers and drying floors. On the extension of the furnace floor is the *cooling-room*, laid with rails, and fitted with water service for handling hot pulp. The tank-house contains three different series of *vats* on three different levels. The roasted concentrates are discharged into a number of *chlorination vats*, which are of special improved design, with bottom discharge and luted lids and rings, being practically gasometers. This first row of vats is placed in line over an open tunnel arranged with trucks to receive the discharged tailings. Below on the second level, are the *precipitation vats*, made air-tight to receive waste chlorine gas, which is forced into fresh pulp in the chlorination vats by an air pump. On the third level are the *waste liquor vats*, which are open-top vats employed to precipitate the final traces out of the gold waters. The *chlorine gas* is generated in a machine which contains all the latest improvements. Connected with this machine are lead mains to convey the gas to the chlorination vats. Alongside the chlorination works are workshops and engine-room, and the whole works are lighted by electricity.* A similar chlorination plant has been erected by the Rand Central Ore Reduction Company, about a mile south of the town.

The *tailings* from the vanners are treated by the *Cyanide* process, which, unlike the Plattner process, is still protected, by patents. The MacArthur-Forrest patents,† under which the cyanide process is worked, are held by the Cassel Gold Extracting Company of Glasgow, and in this country by the African Gold Recovery Company, who purchase tailings to treat at their own works and also allow any company to erect their own cyanide works on payment of a royalty. The latter course has been adopted by most of the large companies on the Rand, for as practically the whole of the tailings from the mill pass through the cyanide works when pyritic ore is being milled, it would not pay to transport this great bulk of stuff to a distance.

The following description of the *Cyanide works* at one of the principal Witwatersrand mines may be of interest:—All tailings from the vanners go down to settling ponds, from which they are subsequently removed in trucks to the cyanide works. The cyanide works have four Portland cement faced circular tanks about 11 feet deep and 24 feet in diameter, each capable of containing 400 tons of tailings with lixiviating solution. The solution first used is a half per cent. solu-

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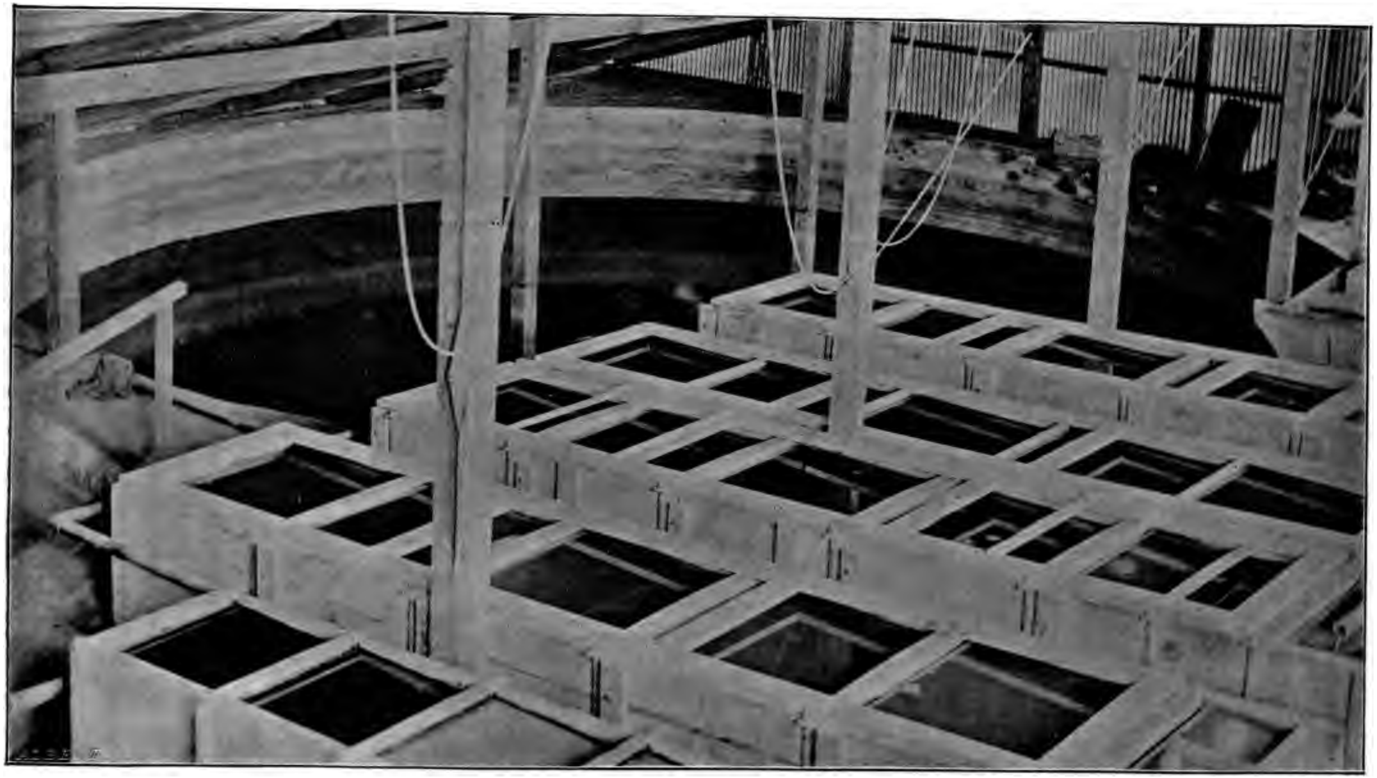
* This description of the Robinson Company's Chlorination Works is taken from the late manager's (Mr. F. Spencer) Report for the year ended 31 December, 1891.

† Appendix XXI.—The Cyanide process of Gold extraction.



LANGLAAGTE ESTATE CYANIDE WORKS.

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tion of potassium cyanide. This "strong" solution is then run off, and a weaker solution, ·3 per cent., used. The tailings are then twice treated with water. All the filtrates are run down to precipitating vats, where the gold is precipitated by means of zinc scrap. The whole operation lasts forty-eight hours. The work done during each day may be considered as follows: Tank "A" filtering, Tank "B" leaching, Tank "C" being filled, Tank "D" being emptied. The precipitating tanks have a continual flow of solution passing through them. The "strong" solution of Monday is the "weak" solution of Tuesday, and so on. The weak solution is only re-made up once to strong solution. After being "strong" and "weak" twice the solution is not used again. The solutions are made up in tanks below the level of the precipitating troughs. The settling ponds are two in number, one wet and one dry, the former receiving the tailings which run down from the vanners at the mill, while the tailings from the dry settling pond are being treated by the cyanide process.

Experiments have been made with a view to treating the *concentrates* from the vanners by means of cyanide, but so far the extraction obtained has not been satisfactory enough to warrant the extended use of this method in place of the more expensive, but more efficient, method of chlorination. The greatest drawback to the latter process is not in the process itself, but in the small percentage of extraction yielded in the form of concentrates by the vanners at present in use, although, judging by the experience of other countries, very much better results may be anticipated from concentrating than have hitherto been obtained on the Rand. The unsatisfactory character of these results has decided several companies to abandon concentrators altogether in favour of direct treatment of the tailings by *cyanide*, and it is certain that such treatment will result in considerable economy as compared with the fourfold process of amalgamation, concentration, chlorination, and lixiviation. If, however, the yield of gold from concentrates can be brought up to the same standard as is now secured in the best mills in Europe and America, the question of concentration will have to be reconsidered, and it is the opinion of expert metallurgists who have devoted much attention to the subject that the Banket ores are peculiarly fitted to yield a very high percentage of their gold when treated by suitable concentrating machinery.

To take the case of a leading mine on the Rand, where the several processes referred to are in simultaneous operation, it is found that the results are roughly as follows :—

Gold saved by amalgamation	50 per cent.
Gold saved on vanners by subsequent chlorination ..	12 ,,
Gold saved by cyanide	28 ,,
Gold remaining in tailings	10 ,,

This shows a total extraction of 90 per cent. of the gold contained in the ore, and is no doubt highly satisfactory. The whole question is one of cost of treatment. The cyanide process has so far proved itself the only practical one for the economical treatment of tailings, and has given a value to thousands of tons of tailings resulting from the previous working of free-milling ores. It dispenses with the great outlay involved in erecting concentrating machinery, but it only extracts at present about 75 per cent. of the gold in the tailings. On the other hand, the vanners *in present use* are hopeless without the cyanide process, as they recover barely a quarter of the gold in the tailings passing over them, and their concentrates have to be chlorinated to yield up their gold. The cost of chlorination at present is about £3 per ton of concentrates, and the cost of lixiviation, or cyaniding, about 10*s*. per ton of tailings, including royalty. The chlorination process, however, extracts fully 95 per cent. of the gold in the concentrates. The proportion of concentration is at present about 1 in 40, that is to say, out of 40 tons of tailings the vanners secure 1 ton of concentrates, and the balance either runs to waste, or has to be treated by cyanide. It is thought that by increasing the percentage of concentration from 2½ to 5 per cent. better results would be obtained, even though this means doubling the bulk of concentrates to be submitted to chlorination, the cost of which would thus be raised from 1*s*. 6*d*., to 3*s*. per ton of tailings. The conclusion of the whole matter is, that at the present time the cyanide process is the cheapest in the market, but if a greatly improved concentrator were to be introduced, the position might be reversed.*

It is barely two years since the cyanide process was introduced on the Rand, and already the results have been so considerable as to justify the statement made by the President of the Chamber of Mines, Mr. Lionel Phillips, in his interesting address at the last annual meeting, that "the Witwatersrand has undoubtedly given the lead to the world in the matter of treatment of tailings." In March, 1891, the first gold recovered from tailings on the Rand was won at the Robinson Company, and by the end of 1892 twenty-two companies were treating tailings and concentrates, with the result that a yield of 211,865 ozs. 16 dwts. was obtained from these sources during last year, as against only 42,954 ozs. during 1891. These figures show conclusively the remarkable success that has attended the increasing number of metallurgical works erected on the Rand. The total weight of gold produced from all sources during 1892 was 1,210,868 ozs. 16 dwts., valued at £4,297,610, or an average of nearly 71*s.* per oz., so that the re-treatment of tailings yielded no less than 17½ per cent. of the total (weight) output of the district. From the summary of output prepared by the Chamber of Mines † it appears that the value of gold recovered direct from the *mills* averaged 72*s.* per oz., as against 78*s.* from *concentrates,* and about 62*s.* 6*d.* from *tailings* treated by cyanide.

The tables given in the Appendix contain full and accurate information as to the rapid progress of the Rand fields, which at present overshadow all the other gold-producing districts of South Africa, as is clearly seen by comparing the returns of their relative outputs. The Cape Colony records have been searched back as far as 1865, but no exports of raw gold appear prior to 1871, when 11 ozs. were exported, valued at £43. The

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* In reference to the above paragraph, the author has received the following note from Mr. MacArthur: "I have read over with great interest the pages in which you compare the chlorination and cyanide processes, which I think you do very fairly. In order to make the comparison perfectly clear, it might be worth while to point out that when chlorination extracts 95 per cent. from a 5 oz. ore, it leaves 5 dwts. in the tailings, and when cyanide extracts 75 per cent. from a 6 dwt. ore, it leaves only 1½ dwts. in the tailings."

† Appendix XXVIII.

Natal records show the first exports of precious metal through that colony to have been in 1870, valued at £250. In the 15 years, 1870 to 1884, the total value of gold shipped from Natal and the Cape was under half-a-million (£435,598), an average of £28,000 per annum, being chiefly the product of the Lydenburg fields. In the next three years an equal value was exported (£443,235); the rapid increase being due chiefly to De Kaap fields. In 1888, the first year in which the Rand began to tell on the output, the exports increased fourfold, being nearly a million for that single year (£909,464). In 1889, they increased 50 per cent. (£1,496,724). In 1890 they still increased, though less rapidly, being under two millions (£1,855,975), but 1891 showed a further leap of more than 50 per cent. to nearly three millions (£2,901,470), and last year another bound forwards of over 60 per cent. to the magnificent total of nearly *four-and-a-half millions* (£4,428,629), being for the first time more than the value of diamonds exported, thus establishing the gold industry in the proud position of the premier industry of South Africa, which position it is likely to hold for many years to come. The total value of raw gold exported to date, in the 23 years, 1870 to 1892 inclusive, is officially recorded as *twelve-and-a-half millions sterling* (£12,471,095), but probably about another million-worth has passed out of the country unrecorded.* That total represents a weight of about 100 *tons of pure gold.* Cast into a single block it would form a cube of over 5½ feet, or a pyramid 15 feet high with a base of 6 ft. × 6 ft., or a column 3 ft. diameter and 25 ft. high. Beaten fine, that quantity of gold could be made to cover 20 square miles of country.

The Rand produces *nine-tenths* of all the gold exported from South Africa, but the rate of production is increasing in other districts also. Whatever the future of the other gold-fields may be, in the Cape Colony, Natal, the Free State, Swaziland, and Mashonaland, at present they are too insignificant, compared with the proved wealth of the Transvaal, to deserve more than passing notice; and, as regards the various Transvaal fields, Witwatersrand naturally dwarfs all the rest. An account of these outside fields will be found in the Appendix. Out of a total of 1,325,394 ozs., the ascertained yield of the Transvaal during 1892, 1,121,042 ozs. were contributed by the Rand.* No other gold-field in the world can show such a record of steadily increasing output. The great Australian and Californian fields, discovered forty years ago, owed their large initial outputs entirely to their alluvial fields, and as soon as these began to be exhausted, and the quartz reefs had to be attacked, the output rapidly declined.† The Rand is entirely dependent on its reefs for its gold, and they are practically inexhaustible, as far as this generation at least is concerned. The gold thus far extracted exceeds £10,000,000 in value,‡ and the annual output, which is at present at the rate of nearly £5,000,000, will go on increasing year by year, till by the end of the century, if not sooner, it will probably have reached £10,000,000 per annum. The rate of increase has been truly remarkable. In 1889, it was 88 per cent., as compared with the previous year; in 1890, it was 35 per cent.; in 1891, 47½ per cent.; and in 1892, 66 per cent.§ During that year over £800,000 were distributed in dividends to shareholders in the Rand Mines.‖ These dividends were contributed by twenty-four different gold-mining companies, while a total of seventy-four companies contributed to the total output of 4½ millions sterling. A list of these companies, arranged in the order of their producing power, is given in the Appendix, No. XXIX.

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* Appendix XXIV.

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* Appendix XXV.

† Prof. Egleston, in his important work on the 'Metallurgy of Gold, Silver, and Mercury in the United States,' estimates the total value of the world's gold-production, from 1851 to 1881, at £940,000,000, of which California produced £235,000,000, and of the latter sum nearly £210,000,000 was yielded by the auriferous gravels of the country. In 1850, the production of gold in California was £10,000,000; in 1889 it had sunk to £2,750,000, and had been never over £4,000,000 in the previous 12 years—and though this decline was partly due to the compulsory stoppage of hydraulic mining, it sufficiently illustrates the transitory prosperity of alluvial mining ventures. The first discovery of gold in California was in 1848, and in Australia in 1851. In 1853, the production of gold in the colony of Victoria alone was 3,150,021 ozs., from which year it rapidly declined, till in 1890 it was only 588,561 ozs. A similar state of things occurred in nearly all the other colonies. New South Wales, which in 1852 produced 818,752 ozs., produced only 127,289 ozs. in 1890; and the produce of New Zealand sank from 735,376 ozs. in 1866 to 193,193 ozs. in 1890.

‡ Appendix XXVI. § Appendix XXVII. ‖ Appendix XXX.

The present work is not intended as a guide to investors, and, therefore, care has been taken to avoid any marked references to individual mines, but rather to treat of the industry as a whole, in its bearing on the growing prosperity of South Africa. It is hardly necessary to draw special attention to the pre-eminent importance of the mining industries to the general trade of the country. Out of a total value of under thirteen-and-a-half millions-worth of articles exported during 1892, over eight-and-a-half millions sterling, or nearly 65 per cent., consisted of minerals. Roughly speaking, one-third of our total exports consists of gold, one-third of diamonds, and the remaining third of all the other products put together.*

To form a just idea of the relative importance of the Rand Mines, it will be interesting to institute a comparison with the metalliferous mines of the United States. In 1890, the total value of gold and silver bullion produced in the United States of America was under 20 millions sterling, the major part of which consisted of silver, the production of gold amounting to only 6½ millions sterling.† No record is given of the number of gold mines which contributed to this output, but the total number of mines producing the above output of gold and silver was 3729. Of this total, 1610 mines produced less than £200 worth of bullion in the year, and 1408 mines less than £2000 worth. The following table shows the relative importance of the gold-producing mines of Witwatersrand, in 1892, compared with both gold and silver mines in the United States at the last Census, in 1890:—

—	United States.	Rand.
Number of Mines reported producing less than £200 bullion	1,610	0
From £200 to £2,000	1,408	4
„ 2,000 „ 10,000	437	15
„ 10,000 „ 20,000	95	10
„ 20,000 „ 50,000	107	21
„ 50,000 „ 100,000	44	12
Over £100,000	28	12
Totals	3,729	74

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* Appendix I.

† 'Report on Mineral Industries in the United States at the Eleventh Census, 1890,' p. 34, by R. P. Rothwell.

At the present time the Transvaal stands *fourth* on the list of the gold-producing countries of the world, and it needs no prophetic vision to see that it must soon rank *first*. In 1890, the gold production of the whole of Australia and New Zealand was only £6,000,000, and of the whole of the United States of America, £6,500,000, and the production of both these countries is now about stationary;[*] so that an increase of 45 per cent. on last year's output will place the Transvaal at the head of the list. That consummation cannot long be delayed. It is difficult to exaggerate, where the facts are so extraordinary. The proved mineral wealth of South Africa is already one of the wonders of the world, but what is not so generally realised is the vast extent of the still unexplored and undeveloped regions of the country.

In making the above forecast, reliance has been placed mainly, if not exclusively, on the progressive output of Witwatersrand, which is already producing over £5,000,000 worth of gold per annum from a narrow strip of country not more than ten or twelve square miles in area, constituting the first row of claims only on the outcrop of the Main Reef series. Until quite recently, it was a matter of pure conjecture to what distance below the outcrop the conglomerate reefs would continue, and, if continuing, to what extent they would remain auriferous. Doubt on both these points is now set at rest by the evidence afforded by the Great Borehole,[†] which has been sunk at a spot nearly 4,100 feet south of the outcrop, and which in June, 1893, actually struck the Main Reef at a depth of 2,400 feet beneath the surface. The significance of this strike will be at once apparent, for it proves that on this part of the Rand the reefs will be within reach of mining operations for at least a mile south of the outcrop, and that it is only a question of increasing the machinery in order to increase the gold output to twice or threefold what it is at the present time.

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[*] The coining value of gold produced in the United States in 1891 is returned as 1,604,840 ozs., valued at £6,600,000, and in 1892, as 1,596,516 ozs.; while the whole of Australasia, in 1891, produced only 1,465,950 ozs., and Russia, in the same year, about 1,200,000 ozs., which, at 82*s.* 6*d.* per oz. represent £6,000,000 and £5,000,000 respectively. The output of Russia, however, is said to be rapidly increasing and to have reached nearly £6,000,000 in 1892. The total gold-production of the world in 1892 is estimated by Mr. R. P. Rothwell, of the 'Engineering and Mining Journal,' at 6,000,000 ozs., or a value of, say, £25,000,000, equivalent to about 185 tons of pure gold per annum.

[†] See Appendix XX.

As to the immediate future of the other gold-fields of the Transvaal, it is impossible to speak with the same degree of certainty; but with such proved mines as the Sheba at De Kaap and the Birthday in the Letaba district, it is evident that the mineral wealth of the country is not confined to the neighbourhood of Johannesburg. The whole eastern portion of the Transvaal, from the Zoutpansberg in the north to across the borders of Zululand in the south, may almost be regarded as one continuous gold-field. Gold is also known to exist in the extreme north-west of the State, in the Waterberg, also further south in the Marico (Malmani) and Potchefstroom (Klerksdorp) districts, as well as in the newly-opened fields of Witwatersberg in the Pretoria district. Alluvial gold in small quantities continues to be found in the Lydenburg district, as well as on the western portion of Witwatersrand. Over all this large area the prospector with his shifting tent is busily at work, and every year new and surprising discoveries come to light.

If there is one lesson which the discovery of Witwatersrand reads us, it is surely this: that we know as yet very little of the land we live in. When the richest gold-field in the world has been lying unnoticed in the track of our ablest explorers for well-nigh a quarter of a century, he would be a bold man who would venture to affirm that any adequate knowledge has yet been gained—I will not say of the resources of South Africa—that is too vast a field to speak of so glibly—but even of those small sections of the country which are considered to have been fairly well prospected. The Transvaal alone is a country more than twice the size of England, and with our limited population we can hardly as yet be said to have more than broken ground on it. We might split up South Africa, south of the Zambesi (not reckoning the sphere of German influence on the west coast), into at least twenty countries as big as England, and yet that little island (excluding Scotland) has a population more than six-fold that of South Africa, including races of every colour; and if we omit the native races, there are more than forty times as many white people in England as in the whole of South Africa. The population of London alone is equal to the entire population of South Africa, and seven or eight times as great as our entire white population. The density of population (that is, the number of inhabitants per square mile of country), is about a hundred times greater in England than in South Africa, including the natives. In the Transvaal there is barely one white inhabitant to every square mile of country, that is 640 acres to every man, woman, and child; and there are four black men to every white.*

These figures are sufficient to prove that we are as yet only on the threshold of that era of advancing prosperity which undoubtedly awaits us in South Africa. It is to-day the Land of Promise; and, great as are the expectations that are everywhere entertained of its future, its destinies are in the hands of a race that can safely be trusted to fully realise them. Compared with other gold countries, it possesses both physical and political advantages, the importance of which it would be difficult to over-estimate. The climate not only entails no hardship on Europeans born in temperate regions, but is so healthy and exhilarating, and so free from either excessive heat or cold, over the greater portion of South Africa, as to invite new-comers to make their permanent home in the land. There are no great mountain-chains, or wide rivers, to render communication difficult, so that railways are built more easily than in almost any other country of equal extent. Fuel and water, for both mining and domestic purposes, are nearly everywhere available; and the pastoral and agricultural resources of the country are so considerable as to be capable, with proper development, of supporting a vast population. As regards its political circumstances, there are, in nearly all the Colonies and States, settled forms of government based on popular representation, which render the fear of violent revolutions a very remote contingency, and thus induce the importation of foreign capital, while the national finances are everywhere in a sound and flourishing condition. Thanks to the thorough, if somewhat rude manner in which the early

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* Appendix XXXIII.—Comparative density of population in South Africa.

Dutch pioneers did their work, the natives have been taught the futility of contending against the white man; and though their rapid rate of increase will probably form the most serious problem which the country will have to face in the future, they have been restrained from the exercise of all their most barbarous customs, have become amenable to civilised law and order, and readily offer themselves as labourers in the mines, as farm-hands and general servants, in all of which capacities their endurance and skilfulness leave nothing to be desired.

In case any reader of these pages should be inclined by the accounts of the richness of the country to contemplate emigration, it may be well to add a word of warning as to the state of the labour market in South Africa. The man with no capital, or no special training and experience in any of the arts connected with mining, will only encounter hardship and disappointment in leaving employment that affords him a livelihood, in the expectation of bettering his condition across the sea. There are no poor men's diggings in South Africa, to offer any temptation to immigrants. The gold and diamonds won in such amazing quantities are won only by the expenditure of immense capital, and the few alluvial diggings that exist scarcely supply those at present working on them with the bare necessaries of life. Living is very expensive in all the mining towns, especially for married men, and the means of educating their children are far inferior to those in England. Many men of fair education have left comfortable situations at home, and after vainly seeking to follow their calling in South Africa have been compelled to become store-assistants, hotel-waiters, barmen, and billiard-markers. There is absolutely no scope for the average clerk and book-keeper, for lawyers, doctors, engineers, and architects, for governesses, or teachers in any department of art and science. In all these classes of labour the market is already over-stocked. But for skilled artisans, for carpenters, masons, engine-fitters, and miners, and for domestic servants, there is still room and to spare. Above all for capitalists, both large and small, there are opportunities for profitable investments such as probably no other country can offer; and, finally, to men of exceptional ability, no matter what their calling, South Africa presents *la carrière ouverte aux talents.*

PART III.

APPENDICES.

CONTAINING STATISTICAL TABLES AND ORIGINAL
ARTICLES BY EXPERTS ON THE SEVERAL
SUBJECTS TREATED OF.

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APPENDICES.

APPENDIX I.

Showing the Relative Value of the Principal Articles exported from South Africa, in the year 1892.

Articles Exported.	Viâ the Cape Colony.	Viâ Natal.	Totals.
	£	£	£
Gold	4,095,512	333,117	4,428,629
Diamonds	3,906,992	..	3,906,992
Wool	2,029,193	583,385	2,612,578
Skins and Hides	488,379	51,862	540,241
Ostrich Feathers	517,009	352	517,361
Angora Hair	373,810	16,142	389,952
Copper Ore	253,681	..	253,681
Sugar	..	119,757	119,757
Coals	..	59,899	59,899
Silver and other Ores	..	16,037	16,037
Goods "over land in transit"	..	156,676	156,676
Other Articles	109,980	28,785	138,765
Non-Colonial Goods	203,511	114,594	318,105
Total Exports	11,978,067	1,480,606	13,458,673
Total Imports	9,487,241	3,165,249	12,652,490

N.B.—The *Gold* and Silver exported were almost exclusively the produce of the South African Republic.

The "*Non-Colonial Goods*" are general merchandise *imported*, and duty-paid, and subsequently exported again elsewhere.

The *Imports* of the Cape Colony include Colonial Government articles to the value of £796,224; and those of Natal include Government Stores and Railway Material to the value of £163,063.

The *total values* of both Exports and Imports are *exclusive of specie.*

APPENDIX II.

VALUE OF ROUGH DIAMONDS EXPORTED FROM THE CAPE COLONY IN THE YEARS 1867 TO 1892 INCLUSIVE. OBTAINED BY COMPARING ALL AVAILABLE SOURCES OF INFORMATION.

Year.	Weight in Carats.	Rate per Carat.			Annual Value.	Value for Five Years.
		£	s.	d.	£	£
1867 1868	200		..		650	
1869	16,550	1	10	0	24,813	
1870	102,500	1	10	0	153,460	
1871	269,000	1	10	0	403,349	
1872	1,080,000	1	10	0	1,618,076	2,200,348
1873	1,100,000	1	10	0	1,648,451	
1874	1,313,500	1	0	0	1,313,334	
1875	1,380,000	1	2	6	1,548,634	
1876	1,513,000	1	0	0	1,513,107	
1877	1,765,000	0	19	6	1,723,145	7,746,671
1878	1,920,000	1	2	6	2,159,298	
1879	2,110,000	1	4	6	2,579,859	
1880	3,140,000	1	1	6	3,367,897	
1881	3,090,000	1	7	0	4,176,202	
1882	2,660,000	1	10	0	3,992,502	16,275,758
1883	2,410,000	1	2	9	2,742,470	
1884	2,263,734	1	4	9	2,807,329	
1885	2,439,631	1	0	5	2,489,659	
1886	3,135,061	1	2	4	3,504,756	
1887	3,598,930	1	3	7	4,242,470	15,786,684
1888	3,841,937	1	1	0	4,022,379	
1889	2,961,978	1	9	3	4,325,137	
1890	2,504,726	1	13	3	4,162,010	
1891	3,255,545	1	5	8	4,174,208	
1892	3,039,062	1	5	8	3,906,992	20,590,726
Totals:	50,910,354	1	4	8	62,600,187	

N.B.—Previous to 1883, the weights and rates per carat can only be taken as approximate. The values of exports from 1872 to 1892, are those given by the collector of customs, Cape Town.

See also remarks on p. 72.

APPENDIX III.

EARLY HISTORY OF THE DIAMOND FIELDS.

OWING chiefly to the vacillating colonial policy pursued by Great Britain with regard to the interior of South Africa, the countries north of the Orange River have repeatedly changed hands. Colonised originally by the Boer farmers, who formed the great *trek* from the Cape Colony in 1835, and established the three Republics of Natal,* the Free State, and the South African Republic, these countries have been successively declared independent, then re-annexed, and the two latter subsequently abandoned. Natal was proclaimed a British Colony in 1843, annexed to the Cape Colony in 1845, and formed into a separate Crown Colony in 1856. In 1849, the Free State was proclaimed British territory under the title of the Orange River Sovereignty, only to be handed back to the Boers again in 1854, and has since remained an independent State. In 1852, the independence of the South African Republic was acknowledged by England, but in 1877 it was annexed to the British dominions as the Transvaal Colony, of short and shameful duration, and retroceded in 1881.

At the time of Mr. O'Reilly's discovery, therefore, in 1867, British territory did not extend further than the southern bank of the Orange River, and in this territory, as already related (page 6), the first diamonds were found. Then followed the first discoveries on the northern bank of the Vaal, in territory claimed by the South African Republic, and, a little later, the discoveries on the southern bank of the river, and still further south in what is now the Kimberley district of the Cape Colony, the last named discoveries being in territory at that time claimed and administered by the Free State. Various native chiefs also laid claim to the whole territory, on both sides of the river, in which the diamond discoveries had been made, so that as complicated a question of ownership arose as could well be imagined.

The first diggers at Hebron recognised the authority of the South African Republic, but in June, 1870, the Government was foolish enough to grant a concession to certain gentlemen, conferring the exclusive right to search for diamonds on the northern bank of the Vaal, which forced the diggers into open rebellion, and at Klipdrift a free Republic was established.

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* Natal had been previously entered by Englishmen. See Mr. Noble's Handbook, new edition, p. 357.

Similarly, on the southern side, at Pniel and Dutoitspan, the diggers quietly submitted to the jurisdiction of the Free State, until it was found that as title-deeds to farms in that State contained no clause for the reservation of minerals, companies were being formed to acquire a monopoly of diamond-digging, or to charge heavy licences to outsiders. The farms of Dorstfontein and Bultfontein, containing the Dutoitspan and Bultfontein Mines, were purchased by Mr. H. B. Webb, and re-sold by him to the London and South African Exploration Company. The Vooruitzigt Farm, containing the De Beers and Kimberley Mines, was bought for £6000 by Messrs. Dunel, Ebden & Co., of Port Elizabeth, and subsequently sold by them to the Cape Government for £100,000. After much trouble it was at last agreed that the diggers should have undisturbed possession on payment of a monthly licence of ten shillings for every claim of nine hundred square feet.

The rival claims of the South African Republic and of several native chiefs to the territory immediately north of the Vaal to its junction with the Hart, including that portion of the diamond-fields, were submitted to arbitration, and on the 17th of October, 1871, the umpire, Lieutenant-Governor Keate, of Natal, gave his award entirely adverse to the Republic, which was thus finally ousted from all dominion on the diamond-fields.* Then came the turn of the Free State. A large part of the territory taken from the South African Republic by the Keate award was allotted to Nicholas Waterboer, the chief of the West Griquas. This chief also laid claim to a considerable tract of country south and east of the Vaal, including the district in which the Pniel and Dutoitspan diamond-fields were situated, and in a letter dated the 25th of August, 1870, he had petitioned the Queen to receive him and his people as British subjects.† The Free State protested that Waterboer had no power to cede "territory transferred to it by the British authorities in 1854, in which no Griquas were living, and over which Waterboer had never exercised jurisdiction;"‡ but though this contention was afterwards admitted to be not unfounded, and monetary compensation was offered by the British Government and accepted by the Free State in 1876, still, in the rush and excitement following the discovery of diamonds, it was difficult for the British authorities to resist the pressure put upon them to annex the territory and establish a strong government there. By the end of 1870, it was computed that from the eastern districts of the Cape Colony fully one-fifth of the young and able men had gone to seek their fortunes as diggers.§ Large numbers had also gone from Natal, and these were followed later by numerous companies from Capetown and other parts of the Colony, and, therefore, on the 21st of October, 1871, the Governor of the Cape, Sir Henry Barkly, issued a series of proclamations, declaring the territory of Nicholas Waterboer part of the British dominions, under the name of Griqualand West.* The intention was to have at once ceded this territory to the Cape Colony, but the final annexation did not take effect till 1880, the new province being meanwhile ruled for the first three years (1872 to 1875), by Mr. (now Sir) Richard Southey as Lieutenant-Governor, and subsequently by administrators, the first of whom was Major Lanyon. The more recent history of Griqualand West forms part of the political history of South Africa, and scarcely falls within the scope of this work.

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* Theal, p. 364.

† Theal, p. 358.

‡ Theal, p. 377.

§ Theal, p. 357.

APPENDIX IV.

THE KIMBERLEY WATERWORKS.

KIMBERLEY has an excellent water-supply derived by pumping from the Vaal River. The total length of main is 18 miles from the pumping station at Riverton to the reservoir above the town shown on the General Plan of the Diamond Fields facing page 3, and the height lifted is 500 feet. The rising main consists of steel lap-welded pipes, 14 inches diameter, and a quarter of an inch thick, the joints being made with spun yarn and lead squeezed in between the plain socket which surrounds the butt jointed ends of the pipes. The water is lifted in three stages by three sets of compound condensing engines, the total lift, including friction, amounting to 760 feet. The first engine is a vertical coupled compound, the piston rods of which, passing through the bottoms of the cylinders, are directly connected to the buckets of two vertical draw-lift pumps placed in a well connected with the river, and delivering into a tank or settling reservoir, a height of 60 feet. Two pairs of horizontal compounds, drawing from this tank, lift the water into an intermediate tank 350 feet higher and situated half way between the river and Kimberley, while a third set of engines, identical with these latter, complete the lift into the high-level tank above the town. The vertical engine has 16-in. and 26-in. cylinders coupled to two 17-in. double-acting piston pumps, the stroke of all being 2 ft. 6 in. The steam cylinders can be worked either compound or non-compound at will, and are both connected with a jet condenser. The four horizontal engines have each 17½-in. and 31-in. cylinders with 2-ft. 6 in. stroke, placed side by side, with cranks at right angles and fly-wheel in centre, and each cylinder is coupled direct to an 8½-in. double-acting piston-pump. The engines are intended to run at 36 to 40 revolutions per minute, so that each of the four pumps is capable of delivering 29,000 gallons of water per hour. Each engine is fitted with a surface condenser, the suction water flowing to the pumps passing through the tubes. In addition, each engine is fitted with a jet condenser, in case of any accident happening to the surface condenser. Each steam cylinder is so arranged that either high or low pressure can be worked as a separate engine, non-compound, when desired, thus affording every security against a total stoppage. At the lower pumping station, steam is supplied to the vertical engine and one pair of horizontal engines by four boilers, while at the intermediate pumping station, where one pair of horizontal engines only has to be worked, there are three boilers. As these boilers were ordered some twelve years ago, while the railway was still several hundred miles from Kimberley, they were specially designed to offer facility for transport and to be very economical in fuel. Each boiler consists of three sections 5 ft. 6 in. in diameter, by 8 ft. long, and is of the Cornish multitubular type. The first section has a single flue containing the grate, the second is bolted close up to the first, and contains a flue fitted with four Galloway tubes, the third section which forms the multitubular part of the boiler, is separated from the second by a combustion chamber. The whole of the machinery was designed by Mr. E. A. Cowper, of Westminster, the consulting engineer of the Kimberley Waterworks Company, and the works were laid out by Mr. George Buchanan, C.E. The boilers, tested at the maker's works, Messrs. Simpson & Co., Pimlico, gave the following excellent results:—

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* Theal, pp. 389–90.

Total heating surface (apparently)	560 sq. ft.
„ grate area	22½ „
Fuel used	Welsh Coal of good quality
Lbs. coal per sq. ft. grate per hour	8
„ water „ „ „ H. S. „ „	3
„ „ per lb. coal from and at 212°	10·87
Percentage of efficiency of coal	73·42

No tests were made of the engines, but it is stated that engines of a similar design showed the consumption of coal to be no more than 1·6 lb. per horse power per hour. For further particulars consult *Engineering*, vol. xxxiii., p. 207.

The head office of the Kimberley Waterworks Company, Limited, is in London. The capital consists of 45,000 shares, £10 each, £7 called. The machinery and plant stood at over £313,000 at the end of December, 1891, exclusive of business premises and landed property. The profits during the year amounted to £27,000, out of which dividends of 5 per cent. were paid, besides providing interest on £110,000 of 6 per cent. debentures. The quantity of water sold to the town and mines was 123,315,084 gallons in 1891, as against 144,416,895 gallons in 1890, and 226,666,915 gallons in 1889. The decrease is accounted for by "the restricted output of diamonds from the four principal mines, with the further drawback of a great increase in the rainfall. No less than 31·1 inches fell in 1891 (by far the highest record during the existence of the company), against 23·2 inches in 1890. The average rainfall of Kimberley and district is about 17·5 inches. Experience proves that the weather has a tendency to move in cycles, and after the recent very wet years, a recurrence of dry seasons may reasonably be expected." * The average price charged for the water was about *one shilling per* 100 *gallons.*

The ruling rates to-day are as follows: the town is supplied with filtered water at 1*s.* per 100 gallons, and the De Beers Consolidated Mines with unfiltered water at 8*d.* per 100 gallons.

APPENDIX V.

REPORT OF THE DIRECTORS OF THE DE BEERS CONSOLIDATED MINES, LIMITED. FOR FIFTEEN MONTHS ENDED 30TH JUNE, 1892.

GENTLEMEN,

Your Directors have much pleasure in submitting their Fourth Annual Report and Balance Sheet to the shareholders.

The declaration of dividends in June and December, whilst the financial year ended on the 31st March, being for many reasons very inconvenient, it was decided to change the date of the closing of the financial year to the 30th June, and consequently the Balance Sheet and Profit and Loss Account now submitted cover a period of fifteen months instead of twelve.

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* This forecast has been verified. The rainfall of Kimberley, as given by the Inspector of Mines, 1892 Report, p. 8, was only 12·951 inches in 70 days in that year, as against 26·337 inches in 93 days in 1891. It is also worthy of notice that early in 1892, the De Beers Company completed a large dam on Kenilworth, calculated to hold 71,500,000 gallons, to conserve the surplus water pumped from the mine, which was formerly allowed to run to waste.

The Balance carried forward at the 30th June, after providing for the payment of three dividends, is ..	£377,532	11	4
During the fifteen months, 3,338,553 loads of blue ground have been hauled and 3,239,134 loads washed, as well as the remaining stock of blue ground at Dutoitspan and Bultfontein, 454,278 loads, yielding 3,035,481 carats of diamonds, which realised, including the proceeds of diamonds of inferior quality from *débris* washing	3,931,542	11	1
The total expenditure amounted to .. .. .. (including the payment of interest on the Company's debentures and obligations, and making provision for their redemption)	2,794,234	3	1
Leaving a profit of	£1,137,308	8	0

The Profit and Loss Account stands thus:—

Balance as above	£1,137,308	8	0
Dividends on Investments	58,289	16	3
Amount received from Cape of Good Hope Bank	3,185	1	4
Transfer Fees at London Office	1,012	14	6
Balance from last year	717,829	0	3
	£1,917,625	0	4
Dividends paid and provided for	£1,382,134	5	0
Bonus in British South Africa Shares	157,958	4	0
Balance carried forward for the fifteen months ..	377,532	11	4
	£1,917,625	0	4

The average yield per load for De Beers and Kimberley is ·92 carats.

The average value per carat	£1	5	6
„ value per load	1	3	5

In his address to the shareholders at the last meeting, the Chairman drew attention to the fact that the Company had obtained the right to purchase one half interest in the farms Oliphantsfontein and Benauwdheidsfontein, on the former of which the Premier mine is situated. Subsequently the right to the remaining half was secured, and in December last year the purchase of the property from Mr. J. J. Wessels, the then owner, was concluded.

In the settlement effected with Mr. H. A. Ward, from whom the option to purchase the second half was acquired, the Company gave him the right to work the Premier mine for a period not exceeding five years.

A Reserve Fund of £621,128 19*s.* 11*d.* has been created, which has been invested in English Consols, and which, whilst adding to the stability of the Company, will have the effect of preventing violent fluctuations in the diamond market.

During the period under review, besides the above, the Company has made a further investment of £100,000 in the British South Africa Company, bearing interest at 6 per cent. and carrying with it certain other privileges advantageous to this Company.

The shares in the British South Africa Company, held by this Company, were partially distributed as a bonus to shareholders with the dividend declared in December, 1891.

In the beginning of the year, money was required by the Cape Government for railway extension, and your Directors, in view of the very large interest of the Company in South Africa, and the obligations consequent thereon, assisted the Government in raising their loan of £1,000,000 by providing £250,000 towards it.

Shareholders will observe that the item of "Development Works" has been eliminated from the Balance Sheet, the Directors considering that the expenses under this head should be charged against current working expenses, the amount standing at this account has therefore been written off to Profit and Loss.

The first drawing on account of the redemption of the 1st Mortgage Debentures took place in July last year, and £187,500 has been paid. Due provision has been made for the payment of the second drawing payable on the 1st August, 1892.

Working of the Mines.

The General Manager's Report on the above subject is annexed hereto.

In conclusion, the Directors congratulate shareholders upon the very satisfactory position of the Company, and the increased dividends which they have been able to declare during the period under review, at the same time adding greatly to the strength of the Company by the creation of a large Reserve Fund.

E. BERNHEIM,
L. BREITMEYER,
G. W. COMPTON,
DAVID HARRIS,
C. E. NIND,
FRANCIS OATS,
} DIRECTORS.

DE BEERS CONSOLIDATED

Dr. **BALANCE SHEET,**

CAPITAL:			
Nominal		£3,950,000 0 0	
Less unissued		1,045 0 0	
			£3,948,955 0 0
MORTGAGE DEBENTURES:			
De Beers First Mortgage Debentures— As per Balance Sheet, 31st March, 1891 ..	£2,250,000 0 0		
Less drawn, 1st Aug., 1891	187,500 0 0		
		2,062,500 0 0	
De Beers Second Mortgage Debentures ..		1,750,000 0 0	
			3,812,500 0 0
De Beers Bultfontein Obligations			745,400 0 0
Redemption Funds: (Mortgage Debentures and Obligations)			
First Mortgage Debentures drawn 1st Aug. 1891		187,500 0 0	
Provision for Redemption of Mortgage Debentures and Obligations		456,934 16 0	
			644,434 16 0
Insurance Fund			25,000 0 0
Reserve Investments Income Accumulation Fund			12,874 0 5
Suspense Liability under Agreements with Leased Companies			70,117 13 1
Griqualand West Diamond Mining Company, Limited, Debentures			158,000 0 0
Bills Payable			302,000 0 0
Creditors			265,520 16 2
Unclaimed Dividends, &c.			1,595 5 6
Reserves for Debenture Interest, &c., accrued to date			69,628 12 6
Interest on Second Mortgage Debentures for Half Year to date			46,145 0 0
Dividend for Half-Year to date, declared 20th June, 1892			493,619 7 6
Balance of Profit and Loss Account			377,532 11 4
			£10,973,323 2 6

We have examined the above Balance Sheet with the Accounts and Vouchers

London, 7th October, 1892.

Kimberley, 7th October, 1892.

MINES, LIMITED.

30th JUNE, 1892. **Cr.**

	£	s.	d.	£	s.	d.
CLAIM ACCOUNT				£7,457,888	6	2
FARMS AND LANDED PROPERTY:						
Kenilworth Estate and Village	£66,241	3	4			
Transvaal Farms and other Property	15,235	14	6			
Wesselton Estate, including Premier Mine ..	451,438	5	10			
				532,915	3	8
INVESTMENTS IN STOCK AND SHARES				466,401	5	10
OFFICES, COMPOUNDS AND STAND PROPERTY ..				58,392	18	1
OFFICE FURNITURE (Kimberley and London) ..				3,914	17	7
SHAFTS AND OTHER PERMANENT WORKS				136,828	4	7
MACHINERY AND PLANT				289,985	16	11
TIMBER, FUEL, AND OTHER MINING STORES ..				101,487	19	1
BLUE GROUND ON FLOORS at cost of Mining ..				466,170	16	11
DEBTORS on Loan and other Accounts				301,454	16	6
RESERVE INVESTMENTS (£650,000—2¾ per cent. Consols at cost) ..				621,128	19	11
BILLS RECEIVABLE				234,076	0	0
DIAMONDS on hand				119,002	4	0
CASH at Bankers and in hand, Kimberley and London				183,675	13	3
				£10,973,323	2	6

W. H. CRAVEN, Secretary.
W. PICKERING, Accountant.

relating thereto, and certify the same to be correct.

COOPER BROTHERS & Co.,
Chartered Accountants.
A. F. TANCRED.
} Auditors.

Dr. DE BEERS PROFIT AND LOSS ACCOUNT,

To WORKING EXPENDITURE:			
Mine Expenses, De Beers and Kimberley Mines	£884,264 11 1		
Floor Expenses, De Beers and Kimberley Mines	337,411 2 2		
	£1,221,675 13 3		
Floor Expenses and Claim Rents, Bultfontein and Dutoitspan Mines.	103,184 8 0		
		£1,324,860 1 3	
Add,			
Blue Ground on Floors, 31st March, 1891	£493,431 16 11		
Less. Blue Ground on Floors, 30th June, 1892, at cost of mining	466,170 16 11		
		27,261 0 0	
			£1,352,121 1 3
To CHARGES:			
Salaries, &c., Kimberley Office		£28,503 4 4	
Stationery, Cables, Travelling Expenses and Sundries		16,625 18 7	
Law Costs		7,944 7 11	
Donations and Relief Works		8,725 0 2	
Commission and Interest		8,214 6 7	
Special Service		3,181 8 0	
Auditors' Fees		1,225 0 0	
London and Paris Office Expenses		7,283 8 2	
Directors' Fees		13,500 0 0	
			95,202 13 9
			£1,447,323 15 0
To Expenditure on Landed Property			14,975 4 4
„ Mashonaland Expedition			6,428 15 6
„ Interest on Capital of Leased Companies			120,490 12 6
„ „ „ Griqualand West Diamond Mining Company, Limited, Debentures			11,850 0 0
To Interest on Mortgage Debentures and Obligations			316,793 2 6
To Depreciation:			
Offices, Stand Property, &c., Machinery and Plant and Investments		£327,322 0 1	
Shafts and Permanent Works		179,476 19 0	
			506,798 19 1
To Redemption Funds (Mortgage Debentures and Obligations)			369,573 14 2
„ Balance, being Profit for the 15 months ending 30th June, 1892, carried down			1,199,796 0 1
			£3,994,030 3 2
To Dividend, 30th June, 1891, 10 per cent.		£394,895 10 0	
„ Do. 31st December, 1891, 12½ per cent.		493,619 7 6	
„ Do. 30th June, 1892, 12½ per cent.		493,619 7 6	
			£1,382,134 5 0
„ Bonus Dividend, 31st December, 1891, paid in British South Africa Company's Shares			157,958 4 0
„ Balance, unappropriated, carried to Balance Sheet			377,532 11 4
			£1,917,625 0 4

for the 15 Months ending 30th June, 1892. Cr.

	£	s.	d.
By DIAMOND ACCOUNT	£3,931,542	11	1
„ DIVIDENDS ON INVESTMENTS	58,289	16	3
„ CAPE OF GOOD HOPE BANK, LIMITED (in Liquidation) :			
Dividend received in excess of estimate	3,185	1	4
TRANSFER FEES, London Office	1,012	14	6
	£3,994,030	3	2
By BALANCE OF PROFIT BROUGHT DOWN	£1,199,796	0	1
„ „ UNAPPROPRIATED as per Accounts, 31st March, 1891 ..	717,829	0	3
	£1,917,625	0	4

W. H. CRAVEN, Secretary.
W. PICKERING, Accountant.

TABLE OF STATISTICS OF DE BEERS CONSOLIDATED MINES, LIMITED, SINCE ITS FORMATION, 1st APRIL, 1888.

Year Ending	Number of Loads of Blue hoisted.	Number of Loads of Blue washed.	Number of Carats of Diamonds found.	Amount realised by Sale of Diamonds.	Number of Carats per Load of Blue.	Amount realised per Carat sold.	Amount realised per Load.	Cost of Production per Load.	Balance of Loads of "Blue" on Floors at close of year.	Dividends.			Capital.
										Date.	Amount.	Equal to	
				£ s. d.		s. d.	s. d.	s. d.			£ s. d.	per cent.	£
1889 Mar. 31, Prior to Consolidation.	944,706	712,263	914,121	901,818 0 5	1·283	19 8¾	25 3¾	9 10½	476,403	1888 Dec. 31	188,329 10 0	5	3,937,050
1890 Mar. 31	2,192,226	1,325,400	1,450,605	2,330,179 16 3	1·09	32 6¾	35 7½	8 10½	1,576,821	1889 June 30	394,786 10 0	10	3,947,865
										Dec. 31	394,895 10 0	10	3,948,955
1891 Mar. 31	1,978,153	2,105,182	2,020,515	2,974,670 9 0	·96	29 6	28 4	8 8	1,449,792	1890 June 30	394,895, 10 0	10	3,948,955
										Dec. 31	394,895 10 0	10	
1892 June 30	3,338,553	3,239,134 and Dutoitspan and Bultfontein, 454,278	3,035,481	3,931,512 11 1	·92	25 6	23 5	7 4·3	1,624,805	1891 June 30	394,895 10 0	10	
										Dec. 31	493,619 7 6	12½	
										1892 June 30	493,619 7 6	12½	

GENERAL MANAGER'S REPORT.

To the Chairman and Directors of the De Beers Consolidated Mines, Limited.

GENTLEMEN,

I have the honour to submit the following as my fourth Annual Report.

The previous Report ended on the 31st March, 1891.

It has been thought best to terminate the Financial year on the 30th June, and consequently the present Report extends over a period of fifteen months, and all figures are for that time.

Plans and Sections of De Beers and Kimberley Mines are given,* which show the workings up to the end of June, 1892.

De Beers Mine.

Output of Blue.—The total quantity of Diamond-bearing ground hoisted is 2,027,559 loads of 16 cubic feet. This quantity is divided between the two winding shafts as follows:—Through the West End Incline Shaft, 591,974 loads; through the Main or Rock Shaft, 1,435,585 loads; the former amount of blue coming from the 700-ft. level or levels above same, and most of the latter amount from the levels below the 700-ft. level. Since about the 1st of March, a portion of the ground mined above the 700-ft. level has been taken out through the main shaft.

Water.—The average quantity of water pumped from the mine has been 6,936 gallons per hour.

Cost of Mining.—The cost of mining has averaged 4*s.* 11*d.* per load. This amount includes all cost for development in the mine.

In future all development work will be included in the Monthly Charges.

Quantity of Blue Ground Developed.—The amount of blue ground in sight at the end of last year was 5,700,000 loads. Since then the West End Incline Shaft has been sunk to a depth of 1025 ft. from the surface, thus proving the blue to that depth and adding 3,294,000 loads to the amount in sight. From the above amount the number of loads hauled during the past fifteen months, *i.e.*, 2,027,559 loads must be deducted, leaving a balance of 6,966,441 loads in sight.

Development Work.—The following work has been done since my last Report:

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* These are not reproduced here.

Main tunnels driven	2,390	feet
Ordinary tunnels driven	16,043	„
Tunnels timbered	3,392	„
Prospect Shaft sunk	39	„
Main or Rock Shaft sunk	123	„
Number 1 Shaft (new)	113	„
West End Incline Shaft sunk	348	„
Passes and ladderways sunk	719	„

The West End Incline shaft has been sunk 348 ft. since the last Report, and is now down 25 ft. below the 1000-ft. level. The Prospect Winze on the North-East side of the mine on the 800-ft level, which had reached a depth of 90 ft. at the close of last year, has been sunk only 39 ft. owing to its having struck the edge of the hard rock from which there was a heavy flow of water which was for a time too great for the small gear erected at the top of this winze to handle.

New Shaft.—As it is possible that the present West End Incline Shaft may in time be destroyed as the mine is worked down and as it is necessary to have two shafts in good working order, a small vertical shaft has been started on the West side of the mine to be used as an escape shaft as well as a shaft for lowering and hoisting the Native labourers. It will have three compartments, and in cases of necessity can be used as a winding shaft.

Floors.—At the end of last year there were 986,581 loads of soft blue and 57,549 loads of hard blue and 109,117 loads of cylinder lumps on the floors.

During the past fifteen months 2,027,559 loads have been deposited and 1,877,543 loads washed, leaving a balance of 1,023,673 loads of soft blue and 170,471 loads of hard blue. There were also 341,729 loads of lumps deposited on the floors, of which 334,756 loads were washed, leaving a balance of 116,090 loads on the floors. The cost of manipulation and washing the blue has averaged 2*s.* 1·9*d.* per load.

Water Supply.—There were nearly three months of dry weather during the summer months when rain is most needed. Heavy rains fell during the early part of the summer and again during March. The enlargement of Kenilworth dam was completed about the end of February, and all water except that used for supplying the boilers is taken either from the mine direct or is pumped from the dam. The dam as at present constructed holds 71,500,000 gallons of water. As water from the river costs 8*d.* per 100 gallons, the value of this dam full of water, after deducting the cost of pumping, will be more than £20,000.

Cost of Working.—The average cost of winning and washing the blue ground has been 7*s.* 0·9*d.* per load (a load is 16 cubic ft. and weighs about 1600 lbs.)

Kimberley Mine.

Work has gone on very regularly at this mine since my last Report.

Output of Blue Ground.—The total output has been 1,310,994 loads. On the 21st day of July, 1891, the Standard Shaft was completed down to the 845-ft. level and hoisting commenced from that level. During the previous year the bulk of the ground was taken from and above the 725-ft. level. Since the gear was lowered to the 845-ft. level four levels below the 725-ft. have been worked.

Water.—I mentioned in my last Report that the water in the mine was giving considerable trouble, not so much on account of the quantity as the manner in which it was necessary to take it out, *i.e.*, with steam pumps. This state of things continued until a connection was made between the new Rock tunnel on the 1000-ft. level and the old workings. This was done on the 4th day of March, when pumping all the water in the mine with the new pumps driven by a triple expansion engine was commenced. A description of this engine was given in my last Annual Report.* No further trouble from water need be anticipated.

Cost of Mining.—This has been greatly reduced during the year owing to the better facilities for working, which enabled a larger output to be made at about the same total cost. This cost has averaged 5*s.* 10·9*d.* per load, which includes the cost of development work.

Quantity of Blue Ground Developed.—At the close of last year I estimated the quantity of blue ground in sight below the 725-ft. level at 1,500,000 loads. Of this amount, 790,993 loads have been extracted, leaving a balance of 709,007 loads between the 725-ft. and 845-ft. levels.

By means of the 1000-ft. tunnel the mine has been proved to that depth, which increases the amount in sight by about 2,000,000 loads, of which 14,986 have been extracted, making the total amount of blue ground now in sight between the 725-ft and 1000-ft. levels, 2,694,021 loads. There is still a considerable amount of blue above the 725-ft. level, but as stated in my last Report it is crushed ground and cannot be estimated.

505,015 loads have been extracted from this level during the year.

Main or Rock Shaft.—This shaft had been completed before the close of last year to a depth of 1261 ft., and the 1000-ft. tunnel had been driven 368 ft. Since that time the tunnel at the 1000-ft.

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* See Appendix VI., p. 143.

level has been driven to the mine a distance of 1134 ft, the exact distance estimated and published in my Report two years ago. This was mere chance and has no significance except that it shows the wall of the mine on the north side to be standing vertical. The tunnel on the 1200-ft. level, which had been driven 404 ft. towards the mine, was stopped owing to a stream of water being struck which it was feared might increase and delay work on the level above, should the tunnel be driven ahead before the new pumps were ready to start.

Improvements.—The improvements which have been made during the year are confined to the new plant for the Main Shaft. These consist of pumping engine and pumps, the compound winding engines (which are more particularly described elsewhere by Mr. L. I. Seymour, our Mechanical Engineer),* and the reconstruction of the Lancashire boilers into multitubular boilers. By this change the boiler capacity has been trebled at about the cost of the freight on a new set of boilers. Five of the new boilers will be placed at the Main Shaft, two of which are already in place.

Substantial brick buildings have been constructed over all this plant.

Floors.—The quantity of blue ground on the floors at the end of last year was 481,256 loads, and 15,523 loads of lumps. 1,310,994 loads have been deposited since that time and 1,361,591 loads washed, leaving a balance of 430,659 loads. 265,876 loads of lumps have been deposited, 220,674 loads washed, leaving a balance of 60,725 loads. The cost of washing has been 1*s.* 11·4*d.* per load, which is a reduction of 1*s.* 2·6*d.* per load on the cost during the previous year.

Steam traction engines for harrowing the blue have been introduced, the same as those used on the De Beers Floors.

Cost of Working.—The average cost of winning and washing the blue ground has been 7*s.* 10·3*d.* per load.

Bultfontein and Dutoitspan Mines.

No work has been done in either mine. The balance of the blue ground remaining on the floors at the end of last year has been washed and all work on the floors stopped.

In conclusion I desire to add that I have had, during the year, every assistance from the heads of the various departments in carrying out the work entrusted to me.

GARDNER F. WILLIAMS,
General Manager.

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* See Appendix VI.

APPENDIX VI.

NEW MINING MACHINERY AT KIMBERLEY. By L. I. SEYMOUR.

Winding Engines for the Main Shaft, Kimberley Mine.

This plant was designed by the writer for De Beers Consolidated Mines, Limited, and built by Messrs. James Simpson and Co. of London, and consists of a pair of inverted vertical tandem compound condensing engines, driving two reels which are capable of carrying 1800 ft. of flat ropes each. The principal dimensions of these engines are as follows, viz:—

Diameter of high pressure cylinders, two	19·5 in.
„ low „ „ „	34 „
Stroke of all cylinders	48 „
Diameter of each air pump, two	24 „
Stroke of each air pump	16 „
Diameter of steam cylinder of the reversing engine	7 „
„ oil cataract „ „ „	4·75 „
Stroke of reversing engine	18 „
Diameter of each high pressure steam pipe ..	6 „
„ „ low „ „ „ ..	10 „
„ „ exhaust pipe to the condenser ..	14 „
„ „ high pressure valve	6 „
„ „ low „ „	8 „
„ „ high pressure piston rod	3·5 „
„ „ low „ „ „	4·5 „
„ „ crank pins	5·5 „
Length of „ „ „	7 „
Diameter of each main bearing	14 „
Length „ „	32·5 „
Diameter of main crankshaft in the middle ..	16 „
Smallest diameter of each reel	9-ft. 1⅛ „
Size of flat ropes used	3⅝-in. by $\frac{9}{16}$ „
Capacity of blue ground skips	100 cubic feet.

These engines are intended to hoist six loads, each weighing 1600 lbs., from the 1000-ft. level in 45 seconds, including filling, starting, discharging and stopping.*

All the steam cylinders are fitted with the Corliss valve gear, having vacuum dash-pots, the cut off being effected by the same lever that works the throttle valves.

Reversing is effected by ordinary links worked by eccentrics fitted on the tail shafts; the reversing engine being fitted with a floating lever so that the motion of the piston coincides exactly with the motion of the small hand lever.

The two high pressure cylinders exhaust into the receiver, which is five feet diameter by eighteen feet long, fitted with sixty-eight two-inch wrought iron tubes, through which live steam from the high pressure jackets, but at a reduced pressure, is constantly circulating. The object of this receiver is to supply the low pressure cylinders with a considerable volume of dry steam to facilitate a quick starting away. An 8-in. balanced throttle valve admits steam to the high pressure cylinders and a similar valve, 12-in. diameter, admits steam from the reheater to the low pressure cylinders.

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* Equivalent to 343 long tons per hour.

Each high pressure cylinder is jacketed with live steam at full boiler pressure, the water of condensation together with a certain amount of steam passing through a Watt's pressure regulator, which reduces the pressure in the jackets of the reheater and low pressure cylinders to about 30 lbs. The final water of condensation is discharged automatically by a displacement trap into the hot well.

Each air pump, of the ordinary marine type, is worked off the cross head. The condenser, 6 ft. diameter by 16 ft. long, fitted with 125 wrought iron tubes 3½-in. outside diameter and 16 ft. long, is situated just outside the winding engine house. All the water pumped from the mine passes through this condenser on its way to the floors.

A circulating pump on the end of one of the tail shafts supplies water for jet injection whenever the mine pumps are not supplying sufficient water to condense the steam.

The following two paragraphs are from the Report of the Inspector of Mines, Kimberley, for 1892:—

"*Fast Winding.*—During the twelve hours from 6 P.M. on January 4th, 1893, to 6 A.M. on January 5th, there were hauled by these engines, from the 1000 feet level at the rock shaft, 4282 loads of blue ground (each containing 16 cubic feet), or 3059 *long tons.** In one hour 420 loads, or 300 tons, were hauled. The engines were working non-condensing, and hauled five loads in each skip.

"*Cost of Winding.*—The cost of coal for winding from the 1000 feet level is 1$\frac{3}{10}$*d.* per load of 1600 lbs., the engine being at present non-condensing. It will shortly be made condensing, when it is expected the cost of fuel will be less than 1*d.* per load. The coal used is Cypergat at £2 11*s.* 6*d.* per 2000 lbs. This coal has an evaporative efficiency of about 50 per cent. of English coal."

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* This probably beats the "record" of the world in fast winding, though, since the date of the above Report, these engines have beaten their own record. In June, 1893, they made 92 trips to the 1000 feet level in one hour, and hauled an average of 413 loads per hour during nine hours' running.

Report on Pumping Plant for Kimberley Mine.

The new plant consists of a vertical triple expansion condensing engine, having cylinders 15½-in., 23¼-in. and 37-in. diameter respectively, with a stroke of 36-in.

The high and intermediate pressure cylinders are arranged tandem, over one crank, the low pressure working on the other, which is placed at the opposite end of the crank shaft and at an angle of 90 degrees with the other.

A double-acting air pump is driven by a rocking lever from one cross-head.and a feed-pump in the same manner from the other engine.

A cast steel spur-wheel, 3-ft. 9-in. pitch diameter, is keyed on the engine shaft, and drives a second shaft 27-in. diameter, by gearing with a spur-wheel 30-ft. pitch diameter made of cast iron, with teeth 6-in pitch by 30-in. face. The gears were made by Fraser and Chalmers of Chicago, U.S.A., the crankshafts by Sir J. Whitworth of Manchester, and the rest of the work, including the pumps, by Messrs, J. Simpson & Co., Limited, of London. A cast steel crank is keyed on the second motion shaft, and drives the T bob by a pitman with 35-ft centres.

On the nose of the bob is hung the spear rod, 1250 ft. long, of hard pine, 14 in. square for the first 500 ft.; 12 in. square for the second, and 10 in. square for the remainder.

The total weight of the rod, including strapping plates and poles, is 69 tons, which will be partially balanced by a counterweight on the top bob, and partly by a second bob placed at the 1200 ft. level.

Attached to the spear-rod at the 250 ft., the 500 ft., the 750 ft., the 1000 ft., and the 1200 ft. levels are cast iron plungers, 13¾ in. diameter, having a stroke of 10 ft., each of which forces the water to the next station above through a riveted steel pipe 14 in. diameter, with joints riveted together.

The foundations for the driving machinery are made of concrete, with the proportion of cement to stone of 1 : 9 on the average.

L. I. Seymour,
Mechanical Engineer for D.B.C.M., Ltd.

APPENDIX VII.

MINERALOGY OF THE DIAMOND.

MOST text-books of mineralogy describe the mode of occurrence of the diamond, and its physical and chemical characteristics, but the following extract from a curious old encyclopædia, entitled 'Pantologia,' and published in London in the year 1813, may be read with interest. Under the article "*Diamond*," it is stated that—

"The art of cutting and polishing diamonds appears to have been known at a very early period to the inhabitants of Hindustan and China; the only material, however, that is used for this purpose in the East being corundum (*adamantinus*), and the apparatus being of extreme simplicity, the jewellers of these countries are incapable of bringing out the peculiar beauty of the diamond in a degree at all comparable to what is readily effected by European artists. The extreme hardness of this gem had baffled the attempts of the jewellers of Europe till the year 1456, when a young man named Lewis de Berguin,* a native of Bruges, endeavoured to polish two diamonds by rubbing them against each other. He found that by this means a facet was produced on the surface of the diamond, and in consequence of this hint constructed a polishing wheel, on which, by means of diamond powder, he was enabled to cut and polish this substance in the same manner as other gems are wrought by emery. Previous to this discovery diamonds were set in jewellery precisely in the state in which they arrived from India; and hence the regular octahedrons were much more esteemed than the rest, both on account of the regularity of the figure, and the superiority of its natural polish.

"Diamonds are cut and manufactured by jewellers into brilliants and rose diamonds; the former being for the most part made out of the octahedral crystals, and the latter from the spheroidal varieties." Then follows a detailed account of the mode of "fashioning a rough diamond into a brilliant, with particulars of the old method of estimating the value of diamonds, according to the squares of their respective weights.

"The mineralogical situation of the diamond is not well ascertained; it occurs in India in detached crystals, in a kind of indurated ochery gravel, but whether or not this is its native bed is unknown. The diamond mines of India are dispersed throughout the whole chain of the Ghauts from Bengal to Cape Comorin; many of these are however at present abandoned, the chief that are now worked being situated between Golconda and Mazulipatam. The earth which affords them being dug up and broken to pieces is carefully washed till the water comes off colourless, and the residue is spread thin on mats in the sun, where the diamonds are discovered by their superior brilliancy. This valuable gem is also procured from Borneo and from Brazil, in the mountainous district called Serro Dofrio, contained in alluvial beds of ferruginous sand.

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* MM. Jacobs and Chatrian call him Louis de Berguem, and give the date of his famous discovery as 1450.

"The principal use of diamond is in ornamental jewellery; it is also employed by glaziers and lapidaries to cut glass, and engrave upon the harder gems; and in the finer kinds of clockwork.

"Newton conjectured the diamond to be a combustible body. Guyton in 1785 inferred its similarity to charcoal, from its leaving an effervescent alkali, after combustion in fused nitre. Lavoisier found that on burning it in closed vessels it yielded carbonic acid. This has also been proved by Mr. Tennant, who performed the combustion in a crucible of gold. Berthollet considered it as crystallized charcoal.

"Since this, Guyton having burnt the diamond in oxygen gas, by the solar rays, and thereby having obtained carbonic acid without residue, he presumed that he had ascertained the diamond to be pure carbon, or the pure combustible matter of the carbonic genus, yielding the pure acidifiable basis of the carbonic acid. But it was Clouet who proposed the conclusive experiment of making soft iron pass into the state of steel, by cementation with the diamond. He therefore secured a diamond with some filings of iron, in a cavity bored in a block of soft iron, filling up the cavity with a stopper of iron. The whole properly inclosed in a crucible was exposed to the heat of a blast furnace, by which the diamond disappeared, and the metal was fused, and converted into a button of cast steel."

And under the article "*Adamas*" occurs the following:—

"The diamond. A genus of the Gmellinian class earths, order siliceous. Consists of silica and carbon; slightly ponderous, extremely hard, lamellar, exhibiting a high peculiar lustre; breaking into indeterminate fragments, parasitical, shining in the dark after being exposed to the rays of the sun, attracting light bodies when rubbed or heated; cracking and losing its transparency in the fire; and at 14° or 15° of Wedgewood's pyrometer, beginning to burn, till at length it entirely evaporates. Eight species from difference of prism. The adamas, or diamond, is found in Borneo, the provinces of Golconda and Viziapour, and at the foot of the Orixa mountains in Bengal; in South America; in the district of Terra do Frio in Brazil, generally in loose sand, or enclosed in a loam earth, very rarely aggregate, or attached to other fossils. Of all mineral substances it possesses far the greatest degree of hardness, transparency, and lustre: fracture straight, and perfectly foliated. It is either colourless, or red, greenish, yellowish, brownish, black, or steel-blue, with sometimes specks or clouds. It is of all gems the most precious; and from its entirely consuming like an inflammable substance, may probably be considered as a very pure species of coal."

APPENDIX VIII.

DIAMOND TRADE ACTS. By HARRY S. CALDECOTT.

ACT No. 48, 1882, was passed by the Cape Parliament to "amend and consolidate the laws for the regulation of the Trade in Diamonds, and to provide for the trial and punishment of certain offences." Part I. defines who may deal in diamonds. It is declared unlawful for any person to have in his possession any rough or uncut diamond unless he is able to produce his proper permit for the same, or to account satisfactorily for, or prove his right to, the possession of the same. Only duly licensed dealers, brokers, cutters, and bankers are permitted to buy, deal in, or receive by way of barter, &c., any rough or uncut diamond. The penalty for contravention is a fine not exceeding £1000, or imprisonment not exceeding fifteen years, or both such fine and imprisonment. Provision is made, however, that the Governor may remit any portion of such term exceeding five years, on condition of such person so sentenced leaving and not returning to any part of Griqualand West (to which portion of the Colony its provisions alone extend). Persons finding diamonds on private property are required to make a declaration of the fact within fourteen days to the Resident Magistrate of the district. No dealings are allowed in diamonds between sunset and sunrise, or on Sunday. Provision is made giving the police the right to detain post packages supposed to contain diamonds sent illegally; also to enter upon and search premises, &c., where stones are suspected to be concealed, and to arrest and search suspected persons, without sworn declarations being required, provided that the Magistrate or Chief of the Detective Department has good cause to suspect, &c. Part II. makes ample provision for licences, permits and registers; and the schedule to the Act contains forms of registers, recognizances, &c., to be used under the Act. All persons authorized to deal, &c., are required to keep a record of their transactions, containing the following particulars, viz.:—

(*a*) Date of all purchases, sales, exports, imports or receipts.
(*b*) Name of consignor, cutter, prospector, seller, buyer, and broker, or consignee, or owner.
(*c*) Total weight of each parcel.
(*d*) Number of stones of 10 carats and upwards in each parcel.
(*e*) Price received or paid, or duty on imports.
(*f*) Weight of any single stone found, received, bought, sold, cut, or consigned (separately or with others), the buyer's valuation of which exceeds £100.

A copy of this register is required to be forwarded monthly to the Chief of Police, &c., and to be produced at other times when required. Provision is also made for the constitution of a Board for the protection of mining interests. Part III. deals with the constitution, functions, &c., of Special Courts for the purpose of trying offences under the Act. Every Special Court consists of three persons, of whom at least one shall be a judge of the Supreme Court of the Colony, and the decision of a majority is the judgment of the Court. Part IV. deals with the recovery of fines by warrant under the hand of the judge presiding in the Special Court; and persons accused are forbidden to sell or alienate property until the case is disposed of. Part V., "Miscellaneous," provides for penalties on servants stealing diamonds, &c., accessories, &c., penalties for inducing servants to steal diamonds, &c. This Act, as stated above, is confined in its operation to the districts forming the late territory of Griqualand West; but Act No. 14, 1885, being a modification of No. 48, 1882, was passed "for the regulation of the trade in diamonds *within the Colony*, and to provide for the punishment of certain offences therein." The principal feature of this Act, differing from the former one, is that offences are not tried before a "Special Court," but by the usual tribunals.

HARRY S. CALDECOTT.

JOHANNESBURG,
May, 1893.

APPENDIX IX.

A FEW REMARKS ON THE GOLD LAWS OF THE SOUTH AFRICAN REPUBLIC. By W. H. S. BELL.

IN a mineral-bearing country like the South African Republic it is natural that much attention should be directed towards the laws regulating mines and minerals. The Volksraad of the Republic had from time to time made laws on the subject, but it was in 1885, that the Consolidated "Gold Law" (as it is commonly called) was passed, which forms the basis of the present law. Experience taught that, as the gold industry progressed, amendments and alterations were constantly necessary, and so the law of 1885 has undergone a series of changes, until now it meets with fairly general approval, although some points, which will be referred to later, are almost universally condemned.

The fundamental principle of the law is that the right to all minerals and precious stones is vested in the State, and the law provides how this right may be granted to others, and upon what conditions, so far as the State and other diggers are concerned.

The law is applicable to diamonds, rubies, gold, and such other precious stones and metals as the State President, with advice of the Executive Council, may from time to time decide upon; but, as a matter of fact, it is framed principally in reference to searching and mining for gold.

The State President, with advice and consent of the Executive Council, has the power to proclaim Government ground as public diggings, and, after consultation with the owner, if possible, also private ground. Three months' notice in the *Staats Courant* (Government Gazette) is given by proclamation previous to a farm being declared a public digging. Within that period the owner has the right to select the spot where he desires to locate his *mijnpacht* (a mining lease which will be hereafter more fully described). The owner may also peg out his "owner's claims"—in number according to the size of his farm, but not exceeding a maximum of ten claims; and he may also peg off preferent claims for his friends or others; whilst the prospector who discovered the mineral upon the property has a first right of pegging off six claims, upon which he is not required to pay licence so long as they remain registered in his name. The owner must also, previous to proclamation, have his homestead and lands beaconed off, and the water he may require in future duly allotted to him. Besides the rights accruing to the owner as above described, he is entitled to one-half of all the monthly diggers' or prospecting licences issued on his property, and three-fourths of all the stand licences.

Upon proclamation of the property the Government appoints all the necessary officials for the purpose of attending to the civil and criminal administration of the field and the collection of the revenue.

It is not proposed in this paper to enter into every detail of the law, but simply to deal shortly with its leading features, and assuming, therefore, that we have now reached the stage when a private farm has been declared "open" for public digging, it becomes necessary to explain what are *mijnpachts*, diggers' and prospectors' claims, water-rights and stands, and their relative rights and obligations.

A *mijnpacht*, or mining lease, as stated above, is granted to the owner, or in case the owner has leased the mineral rights on his property to another, then to the lessee of such mineral rights. Its extent does not exceed one-tenth of the farm or piece of ground. It is granted for not less than five and not more than twenty years, and may be renewed by the holder from time to time. The rent payable to Government is 10*s.* per *morgen* (about two acres) per annum, and the payment must be made in advance, but the Government reserves the right of charging a commission of 2½ per cent. on the value of the finds during the year instead of the fixed rent of 10*s.* per morgen. It may here be stated, however, to the credit of the Government, that it has never yet imposed the charge of this commission, for although it would add a very large amount to the annual revenue of the State, it would, on the other hand, be a very serious imposition on the mijnpachter. Formerly a mijnpacht was liable to cancellation if the rent was not duly paid on maturity, but now considerable grace is given; if the rent should be in arrear for six months the Mining Commissioner of the district shall demand the same through the medium of the *Staats Courant*, and if, after such publication, the rent should remain in arrear for another three months the Government has the right of declaring that the mijnpacht has lapsed. There are several conditions imposed regarding the renewal of a mijnpacht, the principal of which is that the holder of the mijnpacht must be either the owner or the holder under notarial lease of the mineral rights upon the property. The holder of a mijnpacht may transfer a portion to another upon payment of transfer duty, and in that case each is liable for the whole amount of rent of the mijnpacht, or the holder may grant rights to other persons to work upon the mijnpacht for their own benefit; such other persons then become liable for payment of monthly licences to Government in respect of the ground so allotted to them; of these licences the holder gets three-fourths and the Government one-fourth.

A *claim* may be pegged off for either alluvial, precious stones, or for digging on a quartz reef. An alluvial claim is 150 × 150 feet; a claim for precious stones is 30 × 30 feet; and a quartz reef claim is 150 feet long in the direction of the reef and 400 feet broad across the reef.* All claims must be properly pegged, and within a short period proper masonry beacons must be erected at the angles, and proper diagrams, showing extent and the connection between the claims and some other well-known beacon, must be lodged with the Mining Commissioner for approval by the Surveyor-General, after advertising for objections in the *Staats Courant.* In this way it is anticipated that ere long the whole of the claims and mijnpachts on any proclaimed field will be accurately defined, so that compilation plans of the whole may be framed without difficulty. Before pegging off a claim either a prospector's or a digger's licence must be obtained from the Mining Commissioner, and before the licence can be renewed a power of attorney must be filed showing a signature for each claim pegged. None but white persons may hold claims. No more than one claim can be pegged off in the name of one person.

A *prospector's licence* is a kind of provisional licence which is granted by Government at a lower rate than the digger's licence. It enables a prospector to hold and examine his ground while paying small rental; the ground may turn out unprofitable: in that case it can be abandoned; on the other hand, it may be remunerative; if so it can be retained on prospecting licence—unless the Mining Commissioner is of opinion that a digger's licence should be taken out—or a digger's licence can be obtained. The monthly charge for a prospector's licence is 5*s.* per month.

A *digger's licence* is issued at 20*s.* per month, but if the claim in respect of which it is granted has no machinery erected upon it, or quartz is not being extracted from it, the charge is only 15*s.* per month. A prospector's licence can be changed into a digger's at any time upon application to the Mining Commissioner and upon payment of the additional charge.

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* This is Dutch measure, and 30 feet Dutch are equal to 31 feet English.

If either prospectors' or diggers' licences are not renewed at due date the claims cannot be jumped by others, but lapse to the Government. The owner has, however, the right to reclaim his ground within thirty days after the due date by taking out a new licence and paying a small fine. As regards diggers' licences this risk may be easily obviated by what is called "special registration."

Special Registration is obtained by formal application to the Mining Commissioner, who thereupon grants to the applicant a form of notice in which the applicant is described, as also the claims in respect of which special registration is sought. This notice must be published once in the *Staats Courant* and twice in a local newspaper. It calls upon all persons having objections to lodge such objections with the Mining Commissioner within a period of at least one month from the date of the notice. If objections are lodged, they are, after hearing parties, decided by the Mining Commissioner, otherwise a certificate of special registration is granted; upon this certificate certain fees are payable. Special registration confers an almost indefeasible title, and beyond this the claims specially registered do not lapse to Government if the licences are not paid on due date. If the licences on specially registered claims are not paid within six months from due date, a notice is published in the *Staats Courant* demanding the licences to be paid within three months, and if they are not paid within those three months they are sold at public auction, after due notice of the sale having been published in the *Staats Courant.* So that claims specially registered are not liable to forfeiture until nine months after the licences became due. It may be here stated that most of the diggers' claims on the Witwatersrand Gold Fields are specially registered. Prior to special registration a claim is treated in law as a species of movable property, and may be sold by the Sheriff in the same way as movables; but after the certificate is granted it is treated as immovable property, and cannot be sold in execution otherwise than by the process regulating the disposal of immovable property. Claims, when specially registered, may be mortgaged. Besides the form of protection which has just been considered, there is another method by which an indefeasible title may be obtained, and this applies not only to claims but to water-rights, tramways, machine stands and deposit sites (for tailings) as well. It is called *bezitrecht.*

Bezitrecht, which means right of possession, confers upon the owner a title which cannot be disputed; it has only recently been introduced into the Gold Law. Application for this right is made to the Mining Commissioner; it must be accompanied by a diagram, unless a diagram has already been filed. If it is clearly shown that the applicant is fully entitled to the claims or water-right, &c., in respect of which the application is made, and is in the peaceful enjoyment thereof, the Mining Commissioner will grant a certificate of *bezitrecht* at once; but if the proof is not perfectly clear, he will issue a notice calling for objections against the issue of the grant, such objections to be lodged at his office within three months from the date of the notice. This notice must be published three times in the *Staats Courant*, and at least once in a local newspaper, and it must, as clearly as possible, set forth the situation of the property, the nature of the rights claimed in respect thereof, and the name of the applicant and holder. If no objections are filed on or before the expiration of the three months, a certificate of *bezitrecht* is granted; but if objections are lodged, the parties are heard by the Mining Commissioner, who thereafter gives his decision, and from his decision the applicant has the right of appeal to a competent Court within one month from the date of the decision. In the early days of the Gold Fields, when the conveniences in the public offices were of a primitive nature, during a rush of business it frequently happened that transfers were passed which were not perfectly regular, or powers of attorney were mislaid, or other events occurred which later on might be cause for challenging a title. To obviate the risk of defeat of title through some such irregularity or formal flaw, this certificate of *bezitrecht* was introduced. It is intended to apply specially to the following cases:—

(*a*) Where proper transfer has not been passed.
(*b*) Where there is absence of capacity or authority on the part of any person who has given transfer or has pretended to give transfer.
(*c*) Where difficulties have arisen in consequence of the death or absence of the person in whose name the rights in question stand registered.
(*d*) Where, through incapacity or any other cause, the possessor of the rights has been unable to obtain legal evidence of title in the manner previously prescribed by law.

This certificate of *bezitrecht* is much favoured by the mining community in the Transvaal.

Water-rights.—As has been stated above, all water on proclaimed fields, not specially allotted to the owner of the farm at the date of the proclamation, is vested in the State, and the Government has the right of disposing of the same. No water-right is granted unless it is attached (theoretically speaking) to claims, a mijnpacht, or a right to treat tailings. It is secured by written application to the Mining Commissioner, accompanied by a diagram (in quadruple); the application and plans must lay at the Mining Commissioner's office for one month for public inspection. In the meantime, as soon as the application is deposited, the Mining Commissioner issues a notice which must be published three times in the *Staats Courant* and once in a local newspaper. If objection is lodged, the parties are heard by the Mining Commissioner, who decides for or against the applicant, and from his decision there is appeal to the Minister of Mines; if there are no objections, the Mining Commissioner uses his own judgment in granting or rejecting the application. The grant of a water-right does not vest the property in the water in the holder of the right —he has only the use of it, and must, when he has used it, return it to the stream or channel from which he took it. The only exception is, where a person working a mijnpacht, or claims, has procured water by artificial means, then the water so procured remains his property.

Minor rights, such as the right of laying a tram line or water pipes from claims to a battery, are procurable on application to the Mining Commissioner.

Stands.—The lots of ground into which a town on a proclaimed field is divided are called "Stands," or, in Dutch, *Standplaatsen.* They are usually granted for ninety-nine years, subject to a monthly licence of seven shillings and sixpence. They are treated as movable property unless specially registered. They may be specially registered in the same manner as claims (except that advertising is unnecessary), and when so registered they are not forfeited unless the licences are nine months in arrear. Specially registered stands may be mortgaged.

Claims and stands are conveyed from one holder to another by deed of transfer executed before the Mining Commissioner of the proclaimed field, and on all such transfers a duty of four per cent. is paid to Government on the purchase price or value of the property.

The Gold Law makes provision against illicit gold buying and theft of gold and amalgam, also for issue of licences, and a large number of other matters which it is quite impossible to describe in detail in these few remarks.

Taken as a whole the law is a good one, although in many places the work of the draughtsman has not been complete and the wording is not so clear as could be desired. The tendency of modern legislation was to protect the investor who had spent large sums of money in his mijnpacht, or claims. "Jumping," which was formerly allowed, and which gave so much cause for litigation and alarm, is now prohibited. Indeed, it was thought that within a few years our Gold Law would be as good as any reasonable man could wish. But we seem to have gone back a great deal during the last Session of the Volksraad, and we are again face to face with a danger which might do much harm. The danger referred to is the introduction of a clause in the law which allows for mining under public squares, streets, roads, railways, cemeteries, erven, stands, locations, townlands, gardens, bewaarplaatsen, water-rights, and places where tailings are deposited, under which areas mining was formerly prohibited. The present law gives the Government the right, in case application is made for the mineral rights under these areas, to grant the same, subject to sufficient security being given, and which must be regulated by the Minister of Mines, but requires confirmation during the following Session of the Volksraad. The right to mine under townlands will be granted at the request of at least two-thirds of the burghers and inhabitants of the town. The clause allowing this goes on further to provide for the protection of roads leading to the town, of trees and public or private water furrows. This right to mine under the aforesaid areas will be subject to regulations to be formulated by the President in conjunction with the Executive and the Minister of Mines. The widespread apprehension and dissatisfaction caused by this new clause in the law is owing to the fact that it does not give the holders of the surface rights any preferent right to the mineral rights underneath in case they should apply for such mineral rights together with others, and it is feared that this will be a source of abuse and blackmailing in the future.

Another cause for complaint is the authority granted for mining for precious and for baser metals on one and the same claim by different parties. In the Volksraad Session of 1891 some provisional regulations were adopted to provide for the mining of the baser metals and minerals on proclaimed areas; these regulations were passed untouched in the last Session. They provide for the issuing of licences to mine for coal, asbestos, cobalt, phosphate, lead, copper, tin, sulphur, or any other mineral not provided for in the Gold Law; these licences are granted in the same way as diggers' licences, entitling the holder to a claim 150 feet by 400 feet, and for which five shillings per month must be paid. In case precious metals or minerals are found on such claim, the holder of the licence will have a preference for obtaining a licence to mine such precious metals or minerals. Should he not desire to avail himself of this right, another will have the right to obtain a licence for that purpose. The only other important regulation is that if any of the baser metals or minerals be found on a claim taken out under the Gold Law, a person may obtain a licence to mine such baser metals or minerals on such claim, provided he does not cause any damage or inconvenience to the holder of the claim. What "inconvenience" in this respect may mean has yet to be decided.

W. H. S. Bell.

Johannesburg,
October, 1892.

APPENDIX X.

The Tati Gold Fields. By A. von Dessauer.

A German traveller (Mauch), about the year 1865, discovered near the Tati River* some gold reefs, and his enthusiatic descriptions persuaded Australian diggers to prospect the place. A large colony was gathered there in the following years; extensive prospecting works were carried on; and a 5-stamp battery was erected on the banks of the Tati River. But the success obtained did not come up to the exaggerated expectations. The miners gradually left the place in consequence of this disappointment, and troubles with the natives, and other accidents. The last of them went down to the Griqualand diamond fields, just then discovered.

The place, however, was not forgotten, and several companies, floated at Kimberley, sent miners up to resume the prospecting work.

The Northern Light Company absorbed the various holdings on the place, and was afterwards sold to the *Tati Concession and Exploration Company, Limited*, in 1888.

This company obtained an increased concession for all rights from the Matabele king, Lobengula, extending over 1800 square miles, between the rivers Shashi and Romaquabane.

The country is well wooded, but though healthy for men, it is very bad for horses and cattle, which are subject to endemic diseases. The trade with the natives has become important.

The geological formation of the whole district is very monotonous, consisting of granite in its different varieties; sedimentary rocks are nowhere found to any great extent; the minerals composing the granite are very often segregated, following in groups a general direction, and therefore appearing to be true reefs or strata. The quartz lenticulars and segregations are in many cases important in extent and width, and gold-bearing from traces up to considerable yield; some limited parts are very rich.

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* Situated north of S. lat. 22°, and west of E. long 28°, in Matabeleland.

The present Company has almost exclusively confined its works to the so-called Monarch Reef, on which a thousand feet of driving and sinking have been done.

A ten-head Sandycroft battery has been at work, and a new thirty-head mill is erected. The whole output was, up to the end of 1892, about 2000 oz. of gold.

Systematic prospecting will certainly increase the importance of these gold fields, by opening some good gold deposits, and the continuation of the Griqualand Railroad up to Talapye, and the progressing civilisation will diminish the still existing difficulties which naturally surround such a far-away place.

A. VON DESSAUER.

JOHANNESBURG,
February, 1893.

The following is extracted from *Theal's History of South Africa*:—

In April, 1866, rumours began to spread that alluvial gold had been found in the district of Rustenburg, and in some other parts of the (Transvaal) republic. These rumours, which were vague, led to nothing; but in December, 1867, a German traveller—by name Karl Mauch—arrived at Pretoria from the north, and reported that he had discovered rich and extensive goldfields in the Tati district, a tract of country some two hundred miles northwest of the abandoned village of Schoemansdal. The district was drained by streams flowing into the Limpopo, and was nearly uninhabited, being within easy reach of the armies of Moselekatse.

A few weeks after this announcement parties of gold-seekers began to leave the villages of the republic, and to pass through them from other parts of South Africa. Exaggerated reports of the value of the discovery reached Australia, and from that country a party of experienced miners arrived at Natal, expecting to find gold digging an established industry. Some of them were sent to the Tati by a Natal company, others were employed to prospect for gold in that colony. In England, the London and Limpopo Mining Company was formed in 1868, and in April of the following year Sir John Swinburne, its chief manager, reached the Tati with expensive machinery. At this time more than a hundred European diggers were at work, and two or three times that number of blacks were employed by them. Gold was obtained, and some specimens of quartz reef were found to be very rich; but on the whole experience proved that mining there would not pay, and after a short time most of the diggers dispersed.

In the same year that gold was discovered at the Tati, it was found also in the district occupied by the Matabele under Moselekatse. Exploring parties proceeded there, one sent from England being under the leadership of the celebrated South African traveller and artist, Thomas Baines; but they were not successful in establishing mines that would pay the expenses of working, though gold-bearing reefs were abundant.—*The Republics and Native Territories*, Chapter viii., 232–3.

APPENDIX XI.

THE MINERAL WEALTH OF THE TRANSVAAL. An interesting letter from MR. H. W. STRUBEN.

THE first time my attention was drawn to the possibility of there being gold in the Transvaal was in 1857, when travelling to Zoutpansberg with Mr. Alfred Evans of Natal, who found traces of it east of Makapan's Poort, close to where, some years afterwards, Mr. Edward Button found the Eersteling Reef. From 1859 to 1864, Mr. Greening worked silver lead ore on Broederstroom near Crocodile River, district Pretoria, for a private syndicate in Pretoria. He died in Zoutpansberg in 1864, looking for gold. Copper was found about 1866 in Waterberg, by the prospectors of a private Pretoria syndicate. In 1872, Messrs. C. Becker, A. Guzman, P. Marais, and H. Struben, purchased and prospected Pilgrim's Rest. The former two retiring, the latter appointed a Mr. Mansfield, as agent to collect licences. There were from 1000 to 1500 diggers on the field then, but the Sekukuni war, and afterwards the English war, interrupted the work, otherwise a considerable alluvial digging would have been developed ere this. The concession granted, subsequent to the disposal of the property by Struben and Marais, prevented alluvial working, but there is no doubt that in the early years of the discovery large finds of coarse gold were taken out by individual diggers, and that the Blyde and neighbouring rivers contain alluvial gold in paying quantities. Spitz Kop, Mac Mac, Berlin, and other localities in the Lydenburg district have all produced alluvial gold.

During the British occupation, 1876 to 1880, a Mr. Armfield, an Australian gold expert, was appointed to prospect the country, and gold having been known to exist in the rivers and creeks rising in Witwatersrand, he was recommended by a resident of Pretoria to try the Witwatersrand. He worked upon white quartz lodes on the farm of Mr. Cornelius Smit joining on to Paardekraal and Vogelstruisfontein, but found them barren, and failed to recognize the conglomerate beds or the gold-bearing quartz veins along the range, which have since been discovered.

In 1883, Mr. Fred. Struben, who had been working at Pilgrim's Rest, Duivel's Kantoor, Barrett's Berlin, &c., since 1873, went on account of himself and Messrs. H. Struben and E. P. Marais, to inspect the Waterberg district, and discovered gold in creeks and reefs in small quantities, and ancient workings for copper.

In 1884, Mr. H. W. Struben purchased the farm Sterkfontein on the north-west end of Witwatersrand, and Mr. F. Struben prospected it and found gold in reefs. Mr. Struben then purchased another farm further east on the range, and started prospecting for gold on it too. Mr. F. Struben, while superintending the working of these farms, discovered the gold-bearing conglomerates in 1884, and traced them from Groot Paardekraal to Driefontein (Knights), and at the same time, in August, found the rich Confidence Reef, traversing the range, which assayed over 1000 oz. of gold and silver per ton, but it subsequently proved to be an ore shoot and not a permanent reef of such richness.

Prior to these discoveries, Messrs. Green and Bantyes and others had been working for gold on Honingklip and Kromdraai, on the Crocodile River below the Rand, and Mr. Hamerslay had a mill further down the Crocodile River, milling ore from the edge of the metamorphic limestone.

Our man Walker, a coal-miner really, found the outcrop of the rich leader one Sunday by accident while visiting Langlaagte, and comparing the conglomerates brought from time to time by Mr. Fred. Struben (we already knew of the Main Reef), broke pieces off and panned them. The conglomerates were first shown to Mr. Bantyes by Mr. F. Struben, who had found them on Roodepoort and Vogelstruisfontein, and then afterwards as far as Knights. We milled conglomerates from Vogelstruisfontein, both for ourselves and for others, at our private mill, long before anyone else had a mill.

When Mr. Robinson purchased Langlaagte, the mining rights of the eastern portion had already been obtained by Mr. Struben and friends. This is now the Crown Reef Gold Mining Company.

The Transvaal Silvers are situated thirty-five miles east of Boksburg, near the Wilge river, and is argentiferous galena.

The Albert Silver Mine is in the Rhenosterpoort Range, east of Pretoria, sixty miles, and is silicate or sulphide of copper and silver in serpentine country rock.

The Willows Silver is ten miles east of Pretoria, carbonate of copper and silver, several parallel lodes, some copper only, country rock shales one side and rotten diorite on other. Contact lode rich.

I would call attention to the later development of the valley in which Pretoria is situated; it contains old workings for copper, has been worked for silver, lead, limestone, &c., and some few years back for gold. It is now being again exploited west of Pretoria, on Witwatersberg,* for gold, with apparently good results. Gold occurs in rotten reefs below and north of the Witwatersrand. The strong quartzite ranges traversing the country as tilted dykes from beyond Rustenburg to Lydenburg are highly mineralised, and I am confident, will prove another vast mining area. Without entering into geological theories, I would call attention to these ranges of which Magaliesberg is the northernmost. To the north again are trap hills, distant about two miles, following the same direction, and north of these is a strong lode of titanic iron. Between the granite oval north of Witwatersrand and the quartzite ranges of Magaliesberg there is a belt of dolomite; this runs from Malmani in the west to the Drakensberg in the east near Spitzkop. North of Magaliesberg is found freestone, coal, iron, breccia containing gold, and, at one place in the main range, silver. In Waterberg are conglomerates similar to those on Witwatersrand said to be gold-bearing, also gold quartz reefs, and copper workings. In the early days, all experts condemned the Witwatersrand formation and especially the conglomerates. H. W. Struben purchased the first farms solely on the formation, then others on knowledge of the reefs. Percy Whitehead worked cobalt in the Middelburg district many years ago, about 1868 or 1869, produced too much, and brought down price below paying value.

After acquiring all the properties I could get hold of, I informed the Transvaal Government of my discovery in 1885 or 1886, and was granted certain special mining leases.

An Italian, Martinzoni, found 60 ozs. of alluvial gold in Blaauwbank creek in about 1882 or 1883.

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* See Appendix XIV., p. 173.

Coal exists in immense beds from the watershed east of Witwatersrand, to the Drakensberg and down the valley of the Vaal River, hundreds of square miles.

Gold, both in quartz and alluvial, was found in Pretoria town lands, by Mr. Charles Becker in 1875. Asbestos, nickel, manganese, lime, coal, iron, copper, lead, silver, sandstone, occur in various parts of the Transvaal.

H. W. STRUBEN.

OATLANDS, near SIMON'S TOWN.
January 17th, 1893.

APPENDIX XII.

DE KAAP GOLDFIELDS. Compiled by P. A. OGILVIE.

THE Kaap Goldfields* consist of the area watered by the Kaap River, which is one of the southern tributaries of the Crocodile River, flowing into Delagoa Bay. By the natives the Kaap is known as *Umlambo go umgwenyana*, "the river of the little crocodile," which name is the origin of one of its misnomers (Lampogwana). The spot from which the striking and very picturesque features of these Goldfields are best seen, and from which probably the old Dutch pioneers first peered down into the cauldron-like valley of De Kaap, is a magnificent promontory, one of a series towering 3,000 feet above the flats below. On the tableland at the top are labyrinths—scores of acres in extent—of sandstone boulders eroded into huge masses of strange shape. Amongst these caves and galleries, mimic ruined castles and cathedrals clothed with orchid and fern, begonia and gloxinia, are patches of forest-trees (shrouded with the long grey streamers of the orchilla weed) springing up from an undergrowth of heath and aromatic evergreens. In early morning, sheltered from the keen wind roaring along the face of the great cliffs, with the clear rays of the rising sun dazzling his eyes, and startled by the rush of an eagle through the dense blue sky close past his lofty hiding-place, the stolid Boer looked across twenty miles of whirling mist, which drives like a shining white surf against ridges of rocks, to where the jagged Makonjwa mountains rise mass on mass and shut in the land from the Swazi tribes. It is this striking likeness of the *Duivels Kantoor* (the Devil's office) to a sea-washed headland that led him to name it *De Kaap* (the cape), and to call the whole district from it.

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* Between lat. 25° and 26° south, and about long, 31° east.

Here and there were traces of an ancient race, with far greater engineering skill than the Kafirs, and civilised enough to be capable of sustained and organised labour. Such relics as the diggers noticed and preserved were lost in their unsettled life, but it is likely that they were of the same character as those which have lately been examined by Mr. Theodore Bent in Mashonaland, and seem to denote an Arabic civilisation of pre-Mahomedan date. The first noticeable sign was the remains amongst the mountains of properly graded roads, which were usually put down as game tracks or elephant paths, but are undoubtedly the work of human hands. Recently I noticed similar traces amongst the Lydenburg, Haenertsburg, and Zoutpansberg Mountains (occupied by Basutos under the chiefs Makhato and Shebaas); the further north the more plentiful these traces, which fact may be of use in fixing the north as the centre of this vanished civilisation. Then again old mining works (shafts and drives) were occasionally met with, and in two instances old smelting pits were found with clay blast pipes *in situ* containing small quantities of smelted gold; all with vegetation of such age as to preclude any possibility of a Portuguese origin. One of the most convincing proofs, however, was the presence in the creeks, on bed-rock, of charcoal, potsherds, and parts of brass or copper ornaments, in compacted "wash" under boulders of many tons in weight. Nothing will convince me that most of the creeks had not been systematically worked—paddock by paddock—many hundred years ago, and that the very rich patches of *true alluvial* gold which were found—often after months of hard work in proper "pay dirt," yielding only "tucker"—in the most fortuitous way, were not spare ground between old paddocks that had been so buried under tailings as not to be worth stripping. The rains on the mountain-tops, where most alluvial is found, are so incredibly violent that two generations would not have passed before all visible sign of work would have been washed away.

Old works of a different character were not unfrequent, but they suggest rather the work of Kafir tribes some three or four generations back. In sites where hæmatite ore occurs near a heavy growth of sugar-bush (the most suitable wood for charcoal), were often to be found large numbers of clay nozzles, such as certain tribes now use with goat-skin bellows for forging their assegais. These relics were usually found a foot or more underground, and surmounted by trees that must have been scores of years old.

Modern gold-mining in South Africa from 1866 to 1882 may be looked on as an exotic growth which did not bear transplanting. The prospectors and diggers were either old alluvial hands from New Zealand, Australia, and America, and their pupils, or quartz-miners with a knowledge so empirical that previous experience was a positive hindrance in a country where the book of nature was written in a language different from that in which they had learnt their lesson by rote. It took fourteen years to convince them that the "formation" across the ocean was no guide to the occurrence of gold in the new land.

The present phase of South African gold-mining may be said to date from the rush to the Duivels Kantoor in 1882. It was by men then attracted from outside the Republic that quartz reef claims were pegged-off on the farms "Berlin" and "Coetzee-stroom," and held in the hope of winning gold by quartz-mining pure and simple (as distinguished from alluvial washing); and it was by some of these men, as well as by others from amongst the "old hands" who had worked alluvial on the Lydenburg Goldfields (and who now for the first time seemed to recognise the special nature of the gold formations in South Africa), that the Boer Government was induced, after many instances of injustice, to frame in 1885 the basis of the present Gold Law.

Amongst the very first to prospect the district was Tom McLaughlin, when he was working his way south from Mac-Mac on trips which eventually enabled him to locate payable gold in Swaziland. But the man who was undoubtedly the cause of the rush to the Kaap Valley was Charles Durnin. "Charlie the Reefer," a New Zealand and Australian digger, who found some very rich patches of alluvial on the Kantoor plateau, was directly responsible for the erection by Percy Whitehead of crushing machinery on the "Homeward Bound" reef there, and is therefore less directly the founder of the well-developed industry first established in the Kaap Valley, and now attaining gigantic proportions on the Witwatersrand.

In addition to all other obstacles to the progress of the Kaap Goldfields must be reckoned some seven years of ruinous rivalry between the few surviving companies, a rivalry leading to the construction of independent and enormously expensive surface-works, which have had their effect in paralysing the industry. The Sheba, Edwin Bray, and Oriental, on the great lode which brought Barberton into fame, lie block to block some 5,000 feet along the side of the mountain; each has striven to be independent; the Sheba alone could flourish under the strain. The Oriental built an Otto aerial ropeway a mile long, and a ground tramway at least five miles long, to carry its ore to its own mill;

it cut its own monster water-race, and carried out works which must in all have cost half a million. The Edwin Bray secured a mill-site miles further away, cut its water-race, and built an Otto ropeway over mountain and valley, rising 1,700 feet and falling 2,000 feet down to its own mill. The Sheba selected a battery-site midway between its rivals, built an expensive dam, cut its water-race, and put up its own mill and its own Otto ropeway. The three must have spent between them much more than a million on equipment, whilst one transport system and one mill would have saved them hundreds of thousands of pounds. The profitless struggle as to whether the Oriental should swallow the Sheba, or the Sheba the Oriental, now seems likely to end in their unification by purchase and reconstruction under the name of the Sheba Company. So exuberant are the forces of nature in the historic Fever Creek, that the tramway, a full fledged railway with bridges and cuttings and heavy locomotives, has, after eighteen months' disuse, fallen into chaotic ruin. Luxuriant vegetation hides it; floods have razed the embankments; and the eighty thousand which it cost have been sunk, like the Panama millions, out of sight. A monster tunnel is now projected to run through the Sheba and Victory hills to the Kaap River: there is no need to express in words the obvious simplification in work and the saving in expense which this would effect; but only those intimately acquainted with the resources of the district can imagine the magnificent possibilities of wealth that are held out by the construction of so long an adit at so deep a level. The tunnel, if it be put in at all, will be made, not as the venturesome offshoot of the Oriental Company, but by the Sheba Company, which will then own the Sheba Low Level, the Golden Quarry Deep Level, the Oriental, the Oriental Deep Level, Cocking's Nos. 1, 2, and 3 blocks, and the Nil Desperandum. The purchase of the Edwin Bray does not seem to enter into the plan. A list of the Kaap mines producing gold during 1892 is given in Appendix XXXII.

"Geologically," says Mr. Alford, "the Kaap Goldfields are perhaps the most interesting in the world." The general reader is, therefore, without further apology introduced to a summary of the paper written in 1889 by Mr. W. H. Furlonge, E.M., for the American Institute of Mining Engineers: * this gentleman, from a long and varied American mining experience, is pre-eminently fitted to be an authority on a district, in which no other mining engineer has remained so long or has seen so much of the country.

For the purposes of geological description it is best to ignore

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* See Transactions, vol. xviii., p. 334.

political and geographical boundaries, and to include all the country from the eastern edge of the High Veld plateau to the Lebombo flats on the east, and from the Crocodile River on the north to nearly the centre of Swaziland on the south.

In general the mountain ranges run from south-west to north-east, and are similar (though in miniature) both in appearance and essentials to the Sierra Nevada mountains of California—except in the one particular, that their slopes are steeper. This is to be accounted for by the absence of frost: rock disintegration and the consequent formation of a talus, is comparatively slow; and what little rock has been loosened is washed away by the torrents of rain so prevalent during the wet season. Only an eye-witness can form an idea of the violence of these storms, or of the enormous amount of material removed to lower levels during one of them. As a consequence there are no extensive deposits of gravel such as are found in other parts of the world, and no chance of alluvial mining (either river or hydraulic).

Mr. Furlonge failed to find the least trace of glacial action, although he is particularly familiar with its evidences from long residence in the Lake Superior (U.S.A.) district and the country to the north.

As in other gold-mining countries, large granite areas and belts are found, flanked by auriferous schistose and shaly rocks. The greater part is true granite, but contains little mica (almost invariably muscovite): quartz always predominates, and the felspar—principally orthoclase—is accompanied by a large proportion of plagioclase (?albite). There is very generally a little dark green hornblende, and occasionally the rock passes gradually into syenitic granite and thence into true syenite. The decomposition of these granitic rocks presents features which perhaps may have some bearing on the theory of rock-decay—as advanced by Professor T. Sterry Hunt. It is only in flat places (*i.e.*, below water-level in the natural drainage channels, or in places where the surface-water and the rain-water can remain in contact with it for a considerable time) that the granite is found to be decomposed; whilst on the slopes of the hills bordering these areas this rock (which can be traced in unbroken continuity) has merely the ordinary weathered appearance, and is quite solid under the hammer. One of the most noticeable features are the water-washes (known locally as "dongas," and sometimes 200 feet in depth) which cut up the Kaap Valley, and which with the trap-dykes that stand out as sharp ridges, give it so characteristic an appearance. This description of rock-disintegration applies not only to granite, but to all the felspathic and apparently eruptive rocks. In this place it may be convenient to note another instance of the action of rain-water, which seems in this country to have more than usually solvent properties; in many places the outcrop of sandstone beds is observed to consist externally of compact and amorphous silica, and their real nature is only discovered by breaking the rock—when the granular nature of the sandstone is easily distinguishable below the $\frac{1}{4}$ or $\frac{1}{8}$ inch of crust.

Taking the roughly circular granite basin of the Kaap Valley as a starting-point in describing the remaining rocks of the district, we find it bounded on the west by the flat-lying rocks of the High Veld—the abrupt ascent (3,000 feet) to which takes us into an entirely distinct geological horizon: on the other three sides are the rocks amongst which the auriferous deposits of the Kaap Goldfields occur. All these rocks are highly inclined; their strike is in general tangential to the edge of the granite basin, and they dip away from it at angles varying from 60° to 90° Those on the north towards their western extremity are true schists—talcose, hornblendic, and chloritic; but to the east they become more and more argillaceous, and lose their schistose structure, finally becoming true shales. Those on the south as a whole are shales—not always argillaceous, often distinctly hornblendic, and presumably chloritic. Superstratified with them are beds of sandstone and conglomerate, not found on the north; these rocks extend some 30 miles—well into Swaziland—forming a succession of ridges, caused presumably by a series of sharp foldings. The rocks to the north and south finally come together to the east of the basin, while those forming the eastern border are apparently left as a wedge, rapidly thinning out in that direction.

Mr. Furlonge never discovered true gneiss, although the granite close to the flanking sedimentary strata sometimes becomes faintly foliated: nor any schorl, topaz, appatite, or any of the more uncommon minerals.

An eruptive rock is, evidently, geologically the most recent; apparently a true diorite, it has been observed over an area of more than 300 miles square; specimens from all parts are, under the microscope, identical in character. It is in the granite that it most manifestly occurs as true dykes. In many cases it has overflowed as a true lava, and this Mr. Furlonge has never observed in the granite. In other places it is found amygdaloid, in which case the secondary quartz in the cavities is the only trace of that mineral in this rock. It is quite certain that this rock has had, in some manner not understood, a great influence upon the auriferous nature of the adjacent veins and deposits. There are very few other plutonic or volcanic rocks to be met with.

A most remarkable feature is the almost entire absence of lime throughout this district. No less remarkable is the large preponderance of silica—generally in the form of quartz—that is found not only in, and amongst, the shales and schists, but as secondary quartz penetrating every crevice, crack, and gas-pore in the eruptive or volcanic rocks; it is found in notably large quantities amongst the slaty rocks, where it occurs as segregated masses—roughly lenticular in shape, and generally auriferous—interbedded with, and often replacing, them.

Another class of interbedded quartz deposits, often very auriferous, (which may be termed segregated quartz veins), also occurs in these rocks; since they are essentially similar to some of the California veins, there can scarcely be any reason why they should not be equally permanent.

The associated minerals in these two deposits are usually pyrite or pyrrhotite, more rarely chalcopyrite and arsenopyrite. The sulphides as a rule are very auriferous: samples containing less than 5 ounces of gold to the ton are seldom met with, 30 to 50 ounces of gold to the ton are not uncommon, whilst one sample assayed 760 ounces to the ton.

Throughout these tilted rocks are found numerous interstratified beds of quartz rock or quartzite; they are generally large and continue for very long distances, and from standing out prominently they have been locally termed "bars." In Mr. Furlonge's opinion most of these are due to the replacing of the shales or schists by silica; but in other cases it is probable that they were originally strata of sandstone subsequently rendered homogeneous by solutions which permeated them, dissolved to some extent their component parts, and redeposited the silica in a gelatinous state.

These bars have a very important practical value, the principal gold deposits being found in, or immediately adjoining, them—though never seemingly without some eruptive rock being in close proximity. Three methods of the occurrence of gold in them have been noticed. *First*, in the body of the bar itself. The famous Sheba mine is an instance where the gold is found in a "chute" in the "bar" itself; and other mines can be named, where gold has been found more sparingly—but also more widely and evenly—disseminated throughout the whole "bar" for a considerable distance. *Second*, where the bar itself has evidently been fissured or fractured, and another variety of quartz has been deposited in the cracks and crevices so formed. More than one of the richest properties are being worked on this class of deposit, which at 500 feet below its outcrop shows no sign of "pinching."

Third, iron oxide deposits (of great extent) in, and alongside of, the "bars." This ironstone all carries gold, though not necessarily in paying quantities, nor in a state to be caught by mercury. How gold occurs in these thoroughly oxidised ores is not known at present; in the more extensive of the payable deposits it may be averaged at 18 dwts. to 20 dwts. per ton, but the amount which can be extracted by ordinary milling and amalgamation does not usually exceed 7 dwts. per ton.

There is no experience from other parts of the world to guide us as to the probable depth to which these "bar" deposits may continue; they are proved as permanent to some 600 feet in depth, and there is no likelihood of their giving out.

The beds of conglomerate which are enclosed in the tilted strata have been found in a number of places impregnated with auriferous pyrite. This pyrite, and consequently the "free" gold arising from its oxidization, are evidently of later date than the beds themselves, and are entirely confined to the porous cementing material of the conglomerate. These beds, as well as the flat-lying conglomerates of the High Veld series on the western edge of the Kaap Valley, will probably before very long yield a large output of gold

The so-called "alluvial" gold of these fields is really not alluvial at all in the proper sense of the term, and presents so many striking and unique peculiarities, that it is well worthy of description. It is usually found on the tops of rounded hills, and in a position where it could hardly have been placed mechanically. The soil, in which it occurs from 4 inches up to 3 feet deep, is simply a decomposed felspathic rock—probably a diorite *in situ*. There are also usually large amounts of quartz fragments, and most gold seems to occur where these are most plentiful; but—though the nuggets are found sometimes quite smooth and apparently water-worn—the quartz fragments are always angular, and indeed a pebble is nowhere noticeable throughout the whole area of auriferous ground. There can be but little question that these quartz fragments constituted originally the secondary quartz which filled the cracks and crevices of the more decomposed volcanic dyke. This gold, in a distinctly crystalline form, also occurs in considerable quantities, and under nearly similar conditions amongst the flat-lying rocks of the High Veld series.

Of course a certain amount of this gold has found its way into the creeks of rivers, where it occurs as true alluvial; and gold, which is true—though ancient—alluvial, is also found in the High Veld series amongst the sandstone-beds, from which nuggets are occasionally liberated by disintegration. But the amount of true alluvial gold is quite inconsiderable.

Owing to the utter absence of fossils, the correlation of these rocks is at present impossible, as regards the district now dealt with.

The two principal drawbacks to the progress of these goldfields are: first, the absence of fuel; and second, the difficulties of transport. In time these drawbacks will be removed, and these fields will produce a yield of gold that will be small only in comparison to that of the Witwatersrand fields.

There are among the schists and shales of this district enormous quantities of iron ore; for, besides the deposits mentioned above as occurring in "bars," there are stratified beds (hundreds of feet thick) of almost pure hæmatite, together with some magnetite.

Copper is not plentiful; it occurs as chalcopyrite, and the products of its decomposition are chiefly dioptase and chrysocolla, and some rarer silicates.

Lead is seldom found as galenite in these rocks.

Zinc had not been found at the date of Mr. Furlonge's paper.

Antimony or stibnite had been observed in one or two places.

Silver ores are not known to occur, but the gold of the Kaap fields contains about 16 per cent. of that metal.

Mercury, as cinnabar, had been found (in small quantities only) in the tilted rocks.

No salt, gypsum, apatite, or other of the non-metallic minerals have been discovered in quantities sufficient to be of economic value, except asbestos.

Coal in inexhaustible quantities, and of excellent quality, is to be had (within 70 miles) on the High Veld; there are also coal deposits in Swaziland on the flats west of the Lebombo hills near the coast. The only trace of volcanic action is a number of hot springs, mostly giving off sulphuretted hydrogen.

On the eve of going to press (May, 1893), Mr. Furlonge was asked to examine in this district a deposit of cassiterite (tin oxide [*]) that bids fair to equal almost anything yet found in the world.

P. A. OGILVIE.

JOHANNESBURG, SOUTH AFRICAN REPUBLIC,
10th May, 1893.

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[*] See 'South African Mining Journal,' 3rd June, 1893, p. 562, for an account of this important discovery in Swaziland, some fifty miles to the south-east of Barberton.

APPENDIX XIII.

The Low Country Goldfields.

The Murchison Range.—By R. A. Michell.

The goldfield known as the Murchison Range, or Low Country, may be termed a part of the most northern goldfield of the Transvaal Republic in South Africa.

The Range itself is a spur of the Drakensberg Mountains, runs slightly to the north of east, is situated in latitude 24° south, and extends from longitude 30° to 32° east of Greenwich.

To the north of the Range lies the Klein Letaba goldfield, the latest discovered portion of this united northern goldfield.

To the south of the Range the Silati valley and the Thabini goldfields are situated.

To the west, extending over the slopes of the Drakensberg Mountains, are the Woodbush, Haenertsburg, and Marabastad goldfields, and to the east this vast district is shut in from the coast and Portuguese territory by the Lebombo Mountains.

The northern side of the Range is watered by the Great Letaba, a river fed from all sides by numberless streams.

To the south of the Range runs the Olifants River, also fed by numerous tributaries. These two main rivers join one another to the east at the foot of the Lebombo Mountains, and the one great river is again absorbed by the Limpopo, which flows away to the south-east into the Indian Ocean.

To describe the whole of this vast and almost unknown area would be impossible; all we can say about it at the present moment, is, that it is known as a mineral district in which have been discovered gold, silver, cinnabar, copper, iron, and lead. In the earlier days in the search after gold, the Murchison Range was one of the first districts "rushed" by the prospectors, and the whole of the slopes of the Range was taken up in claims and held for some time with the idea that the speculative gold-mining investor would find sufficient capital to develop what was supposed to be the richest gold-bearing district in South Africa.

These hopes have not been realised, and the district has been almost lost sight of in the discoveries which have been made on the Witwatersrand. Sooner or later, however, attention will undoubtedly be directed to properties on the Range, and to the discoveries which have been made since the earlier days to the north and south in the Letaba and Silati valleys.

With regard to the northern section of this field, the mining properties known as the Birthday * and the Ellerton, are already prominent as leaders in the development of the district, and when it is understood that these mines are twenty miles apart, and that discoveries of gold-bearing "leads" have been made both to the east and west of these extraordinarily rich properties, it is impossible to doubt that, sooner or later, this area, extending for between thirty and forty miles, will in itself become a great mining centre.

On the Range itself, hidden away amongst the hills, lies the little township of Leydsdorp. Within easy reach of this spot are to be found the properties known as the Murchison Crown, the President, the Gravelotte, the Free State, the County Down, and numerous other properties on which exploration work has at one time or the other been carried on, but owing to the plethora of mining ventures in other and more accessible districts, the whole of the Range has been neglected, and with the exception of the President, Gravelotte, and Free State, little or no development work has been done except by fits and starts during the winter seasons.

To the south of the Range, extending over a large area, are found the blocks belonging to the Harmony and Oceana Companies. Portions of these properties have been, or are about to be proclaimed as public goldfields, and seeing that active mining work is being prosecuted by the Sutherland Reef Gold Mining Company, and by the Silati River Gold Mining Company, on gold discoveries made on their properties, attention must, sooner or later, be extended to this district.

With regard to the geological structure and the nature of the gold-bearing reefs on the Murchison Range and in the surrounding district, Mr. A. R. Sawyer, in his little book on Mining in the Murchison Range, gives us the best known description. To the geologist this portion of the Transvaal is undoubtedly of great interest. Fresh discoveries are continually being made, and should the segregated, lenticular, or bedded veins, eventually prove in depth to be of the true fissure description, it is impossible to foretell the value or importance these northern fields may assume in the future prosperity of the Transvaal. The great drawback to the Murchison Range district has arisen from its inaccessibility and the difficulty of obtaining efficient communication with coast ports, or the trade centres of the Transvaal.

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* The Birthday produced 13,618 oz. of gold in 1892. See footnote to Appendix XXV., p. 221.

The transport question has, however, been vastly improved by the advent of railways to Johannesburg and Pretoria, and on the completion of the Silati Railway, now in course of construction from Nelspruit to Leydsdorp, the difficulty of obtaining material for mining and provisions of all descriptions for use in the Low Country will virtually be at an end.

The opening up of the district, when once systematically taken in hand, will also minimise, what is now the scourge of the district during the summer season, *fever*. Men are naturally afraid to face this disease, and whilst we do not for one moment wish it to be thought that there is no danger, we cannot help asserting that it is due to the faults of companies employing labour, and of the individuals themselves, that such a large number of cases occur, although few are fatal. Before closing this paper we would point out that besides the mineral wealth of the district, the Murchison Range and surrounding country is admirably adapted for certain classes of agriculture. Cereals, together with tea and coffee, will undoubtedly flourish, and should pay handsomely with careful cultivation. Railway communication from the coast to the Palabora, and from there, by means of branch lines to the Letaba and Silati valleys, the main trunk running through to Pietersburg, "the southern gate of Mashonaland," which point will, within the next few years, be in direct railway communication with Pretoria, should greatly enhance the value of the Low Country generally as a producing centre, and draw the attention of the outside world to this district.

ROBT. A. MICHELL.

JOHANNESBURG,
9th May, 1893.

APPENDIX XIV.

THE WITWATERSBERG GOLDFIELDS.*

(From the Johannesburg 'Star' of 15th November, 1892.)

WONDERFUL WITWATERSBERG—NEW FIELDS TO THE NORTH—
A RICH ANTI-CLINAL TO THE RAND.

THE Witwatersberg valley, bounded on the north by the bold escarpments of the Witwatersberg hills, and on the south by the slopes of the Kalkheuvel range, stretches away due west from

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* Not to be confounded with the famous Witwatersrand fields, which lie some thirty miles further south.

Pretoria, with a more or less east and west course, the town lands on that side of the city forming the entrance to the valley. Parallel with it, behind the Witwatersberg range, lies the beautiful valley through which leads the main road from Pretoria to Rustenburg, hemmed in on the north by the high walls of the Magaliesberg. A bye-road to Rustenburg passes down the Witwatersberg valley also; and, as the traveller goes westwards by this way, he cannot fail to notice the numerous isolated patches of dense bush which are scattered over the many bluffs of the hills on his right hand. These indicate the position of old workings, which are now almost impenetrable; but they give evidence that, long years ago, the metalliferous wealth of this region had attracted the attention of races who have vanished without leaving track or trace behind. These holes have not been lately explored; but there is little doubt that the "old men" were in search of gold, for the strata are interlaminated in many places with auriferous reefs, from the decomposed outcrops of which the gold may be easily obtained by rough crushing and panning. At a later date, about the time that the auriferous wealth of the Transvaal had begun to attract the attention of the moderns, this neighbourhood was eagerly prospected for the precious metal, doubtless with satisfying results, for in the Magaliesberg valley is still to be seen a five-stamp battery, and a large iron overshot wheel to provide the necessary power. These appliances were erected by the side of the Crocodile River, and it appears that the engineering skill of the builders was inadequate; for, although a powerful stream of water was at hand, they were unable to turn aside a sufficient volume for the working of their wheel. The plant remains just as it was left, the feed-hopper being still full of good ore, the whole equipment remaining as a sad monument to the unfulfilled hopes of its projectors. About the time when these works were undertaken, the first rush to the Witwatersrand occurred, and the prospectors left this district for one which seemed to offer better things. A similar course of misfortune attended a company of adventurers known as the Beckett Syndicate, who commenced milling upon a more adequate scale in the Witwatersberg valley. Being assured that the country was valuable, they purchased certain mineral rights, and began to crush ore from a rich and persistent reef running through the centre of the valley. Although the ore was entirely free milling, they were unable to obtain gold enough from a five-stamp battery, by their peculiar method of working, to allow them to pay the royalty they had guaranteed to certain farmers who owned the land; and, seeing no way out of the difficulty but by abandon-ment, they closed down the mine. The property remained untouched from that date until very recently, a period of some five years or thereabouts, when the Witwatersberg Syndicate appeared upon the scene, determined to take up the work at the point at which the early pioneers had laid it down.

The property on which mining rights have been obtained by the Syndicate comprises no less than 40 square miles of lovely country in the Witwatersberg valley, together with an area adjacent to the northern boundary, situated in the Magaliesberg valley. The first-named block joins the western line of the Pretoria town lands, at a distance of some eight miles from the city; and, embracing the whole width of the valley (which has an average breadth of three or four miles), continues westwards for thirteen miles or so, having within its area the farms Elandsfontein, Schurveberg West, Welgelund, Broederstroom East, and De Erf, while on the other side of the Witwatersberg the farms are known as Rietfontein and Rietvley, or Uitzicht. The property is, therefore, an extensive one. Not only is it valuable by reason of its mineral resources, to be immediately described, but it is possessed of other advantages which can neither be ignored nor despised. The soil, for instance, more especially on the higher ground, is well adapted for pasturage, while in the lower part of the valleys, which contain a great depth of rich soil, magnificent crops of cereals and other produce may be grown. The Crocodile River, which is fed from the large gathering ground to the north of Witwatersberg, attains considerable volume by the time it reaches the Kalkheuvel range, through which it passes into the Witwatersberg property. There it passes across the valley in a winding course, forming a boundary between the farms Welgelund and Broederstroom; and running through a kloof in the last-named range, enters the Magaliesberg valley at no great distance west of the farm Rietfontein. There are minor streams of more or less importance, which water the various farms, but one very noticeable river is that which rises in the limestone of the Kalkheuvel hills, and affords a large quantity of pure water as it crosses the farm Broederstroom. It is said that the amount of water running throughout the year is practically constant. It will thus be understood that, owing to the excellent facilities for the erection of dams, and to the very varied contour of the ground, it would be possible not only to keep batteries supplied with an unfailing quantity of good water, but also, by the aid of proper engineering works, to obtain an enormous amount of power from turbines for the driving of machinery, and thus to do away to a large extent with the necessity for using coal or other fuel. There is upon the farms, also, a considerable amount of timber; but under wise management this will doubtless be allowed to remain. The air on these southern slopes of the Magaliesberg is most invigorating, and it is said that a cooling breeze is generally blowing along the valleys during the summer.

The mine and works taken over by the Witwatersberg Syndicate from the former owners, the Beckett Syndicate, are situated at a distance of two and a half miles or so apart, at opposite extremities of the farm Broederstroom. The mill is a five-stamp Sandycroft battery, situated on the banks of the Crocodile River, at a height of some 30 feet above the normal level of that stream. It was attempted to drive the mill by means of a turbine, and a water furrow, running for a considerable distance along the bank of the river just named, was continued to the head of the turbine inflow. The work, however, was badly contrived, and the Witwatersberg Syndicate have found it necessary to substitute a steam-engine. A good deal of crushing was done by the Beckett Syndicate from the Gossany Reef; but far more gold went with the tailings than was caught upon the plates. Pannings from the tailings show that they are very valuable indeed. In addition to the mill, there are various other buildings and offices at hand. The Syndicate has lately completed a small trial crushing, and although the battery is by no means in such good order as it would be possible to place it, the result of the ore test is in every respect satisfactory. The mine was already developed in a small way when taken over from the Beckett Syndicate, so that the persistence of the reef body in depth was more or less proved. A certain amount of work has been done during the last month or two, and this has sufficed to open the reef still further, and to show that, to a depth of 100 feet or thereabouts, the reef presents a continuous and improving body of good ore. The drives are extended for about 200 feet along the reef, at a depth of 80 feet. The only means of drawing out ore and unwatering the mine up to the present have been a pair of ordinary windlasses; but a powerful little winding-engine is now in course of erection at one of the incline shafts, and will, when completed, be able to keep up a good supply of rock to the mill.

The reef upon which work has been mainly done—and which may therefore be called the Main Reef—runs in a parallel line with the course of the Witwatersberg valley, near its centre, and has been identified at various points of the property from end to end. It has also been followed westward for some three miles or more beyond the boundary of the farm Broederstroom East, to the farm Leuwkloof, where it is being explored by Messrs.

Farrar and Imroth. It can be said, therefore, that this reef is continuous for a distance of nearly 20 miles, for careful examination of it at the various points mentioned affords strong evidence that the ore body is one and the same throughout. It consists of shales penetrated by a mass of quartz, undoubtedly by intrusion, and interlaminated with it in an irregular manner through a thickness varying from a few inches to about five feet. For instance, at the Broederstroom mine the reef widens from three feet at the surface to five feet at a depth of 100 feet, while at the workings of Imroth and Farrar the reef is only a few inches wide at the surface and widens at a short distance to about 18 inches. One or two of the quartz leaders in the first-named mine are more persistent than the rest, and have a thickness of about three inches. An examination of the ore body shows that the shale and quartz are frequently mixed up in a way that resembles the mingling of pebbles and cement in *banket*, except that the fragments are angular. In other respects they are entirely different, and are due in origin to wholly different causes. This ore body on Broederstroom is a reef in the proper sense of the term, while a conglomerate bed is not. The whole of the ore, as far as explored, is of a friable, gossany nature, and will probably remain so for another 200 feet, so that the milling will be rapid, and the gold easily collected. Pannings taken from all parts of the reef show almost invariably good results, although a large proportion of the gold is indistinguishable on account of a filmy coating of iron oxide. Fire assays have shown extremely good values, which have been well corroborated by the milling tests previously referred to, which was made under disadvantageous conditions. Within a few yards of the place where the hauling engine is being erected, runs the strong current of pure water from the Kalkheuvel limestone mentioned above, and it is contemplated to dam this stream nearer to its source, and convey it in pipes to a turbine which will supply all the power required for the various mining and milling purposes on the farm. The mill will be erected eventually near the mine, and thus everything will be conveniently disposed and economically worked. This matter in itself is an important one, and the facilities thus derived add greatly to the high value of the property. The conditions for working, taking them as a whole, are equalled by but few districts in the Transvaal, and are certainly far better than those along the Witwatersrand.

The Main Reef is not the only reef on the Witwatersberg property. On the range there are found several other lodes of a similar kind, which have been traced for long distances, and give, on panning, surprisingly good results. They have, however, not been worked to any great extent, except as prospects, and they are in the neighbourhood of those old workings which were spoken of at the commencement of this article. It is doubtless from these reefs that the ore was extracted which was to have been milled at the battery now standing deserted a few miles away in the Magaliesberg valley. They, like the Main Reef, are all gossany; and they are all composed of a mass of intermingled quartz and indurated shale, the whole being due to the intrusion of the quartz. At the back of Witwatersberg, on the farm Rietfontein, there has been discovered a quartz reef which has been opened at two points about three-quarters of a mile distant from each other. It presents an entirely different appearance from any of those already described: for whereas they are interbedded reefs, this is a true fissure lode, cutting directly across the line of bedding of the strata at a high angle, while having a strike parallel to that of the beds around it. It consists of a wide mass of white quartz, generally uncrystallized and vitreous in appearance, except in the neighbourhood of the fragments of sandstone which are included in its body. It has a width, when opened, of about eight feet of more or less solid reef, and has a tendency to send ramifying sheets into the sandstone country rock, thus widening itself somewhat. It is accompanied by a leader of gossany stuff a few inches in width along its length, and there are detached portions of the same decomposed ore matter throughout the reef. In places visible gold is plainly to be seen, and the pannings from all parts of the lode are most satisfactory. It has only been partially broken, and it is somewhat difficult of access at present, being found high on the northern slope of the Witwatersberg, amid a dense growth of thorn and other bush. It is an interesting speculation as to whether this reef is of the same age as those which, on the other side of the range, run in the bedding lines of the strata, and at what depth they are likely to unite. This is, however, a matter more of scientific than practical interest; and whatever may be the case, there is good evidence that the reef is a very valuable one, and likely to extend for a long distance in strike and dip. There are several other reefs similar to this, located higher on the hill, but not so large and prominent.

The geological characteristics of the Witwatersberg district are similar, in the main, to those which are found in the other auriferous regions of this part of the Transvaal. A brief description will suffice. It is generally known that between the Witwatersrand and Pretoria is an axis of granite running east and west. This axis forms the foundation, so to say, upon which the other formations have been built. At an early geological epoch, the lower formations, such as the conglomerates and sandstone quartzites of the Rand, and the series beneath them, consisting of mudstones, schists, shales, and quartzites, which are the lowest beds that have hitherto been discovered in the Transvaal, were lying in an approximately horizontal position upon the granite. The latter, being upheaved along the axis mentioned, lifted the strata with it, the formation being thus made to dip on one flank in a southerly direction as at Johannesburg, and on the other flank in a northerly direction as at Pretoria and the neighbourhood. The axis of the great fold was in succeeding ages eaten away by denudation until the bed rock of granite was reached and exposed over large areas, so that at the present day there appears to the uninstructed no possible connection between the beds in which the Rand mines are being worked and those in which the Witwatersberg reefs are found. It will be understood, however, by the initiated that they are simply separated portions of what were at one time continuous formations, although it must be distinctly remembered that the Witwatersberg beds are lower in the geographical horizon than those of the Rand conglomerates. They are, in fact, identical with those in the Barberton district and along the great Drakensberg Range up to the Low Country, where they are still the same beds, although perhaps differently influenced by local eruptive and other action. This fact—namely, that the formation is identical with that in which so many important gold deposits have been found in other districts—is in itself a favourable one. A section of the Witwatersberg taken directly at right angles to the line of strike of the strata, shows that the country is composed of alternating beds of shale and sandstone, altered in depth to a kind of slate and quartzite. A great dyke of trap rock, probably diorite, is seen to crop out along the southern face of the Witwatersberg, and has undoubtedly had a very beneficial influence upon the gold-bearing value of the reefs. The Kalkheuvel is composed of calcareous strata, and upon its southern flank is found a wide lode of clean galena, or sulphide of lead, which is said to carry a large proportion of silver. Upon the northern side also of this range is to be found an eruptive dyke of the same kind as the one mentioned above. In fact, trap intrusions are common in the district. The country rock has a uniform dip of about 39 or 40 degrees to the north. It does not appear that any portion of the conglomerate beds of the upper or Rand formation have been discovered in this region. In many places there is found upon the surface a gravelly deposit cemented with oxide of iron. This is merely a recent formation of no importance, but it is deceptive to those who do not understand its nature. A variety of hæmatite is also found in places upon the property.

It will be unnecessary to add many words of commendation, for those who have read this article so far will have satisfied themselves that in the Witwatersberg properties there exists a field for profitable gold-mining second to none in the Transvaal, so far as discovery has at present progressed. The advantages possessed by the farms embrace an abundant and constant supply of good water, which will be able to afford a large proportion of the power required in the various mining operations, so that coal will be more or less unnecessary. This is an advantage possessed by no mine along the Rand; and when the prominent part played by fuel in the cost of working along the Main Reef is considered, it will be admitted that the advantage mentioned is a most important one. The reef stuff, again, is free milling, and is likely to continue so for a considerable depth; it is easily broken and crushed, and will thus permit of operating expenses being kept down to a low comparative limit. When it is stated finally that the direction of the Syndicate's operations—initiated by Mr. S. B. Height, who has clung to the Witwatersberg with a tenacity that no reverse of fortune could affect—is in the hands of Mr. Edward Jones, the pioneer of deep levels, and the leader of mining reforms on the Diamond-fields, it will be admitted that the auspices for the future of the property could not well be more favourable. The advantage of this guidance is already evident, and it may confidently be predicted, in view of the fact that no financial difficulty need now be anticipated, that in a short time the Witwatersberg district will take high rank as a gold-producing region. The gold already turned out is of finer quality than that produced in any other part of the Transvaal, and it may be taken for certain that the monthly yield will constantly increase and steadily multiply from the date when milling operations are commenced in earnest, and this will be not later than the end of the present month.

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Since this article was written a large amount of development has been made on the property by sinking shafts along the strike of the reef; the latter now being opened up in half a dozen places within a distance of over a mile from the main workings. Test crushings were made amounting to about 700 tons, yielding from 8 to 15 dwts. per ton, and the resources of the Syndicate are now being applied to fully developing the mine, with the object of floating it into a large company. A most influential company, "The Gold Fields of South Africa," has taken a large interest in this Syndicate.

From the developments which have been made, the prospect of the Witwatersberg district becoming a large mining centre, is beyond a doubt.

EDWARD JONES.

JOHANNESBURG,
10th May, 1893.

APPENDIX XV.

THE MASHONALAND GOLDFIELDS. By W. E. FAIRBRIDGE.

I SHALL attempt here nothing more than a glance round the half-dozen gold-bearing districts comprised under the name of Mashonaland, as they stand at the commencement of the winter season of 1893, feeling that with rapid change and progress impending, the readers of this volume should not be permitted to mistake what was, for what may have become. Seeing, for instance, that the flotation of companies and the importation of batteries is proceeding in an ever accelerating degree, and that what is said on this score to-day will be obsolete in six months time, it will be safer merely to describe the several "Fields," and what the reefs they contain are capable of yielding.

A word or two in the first place will not be amiss on the subject of "Old Workings," with which, it is hardly an exaggeration to say, the country is honey-combed from the latitude of the Crocodile, to far beyond that of the southern end of Lake Tanganyika. Less has been done and written in the way of studying and examining the manner in which the "old men" mined than could be wished, but it seems certain that they confined their attentions to high grade ore, that they preferred open cuttings to subterraneous tunnelling, and that in few cases did their probably rude appliances permit them to go deeper than 100 feet. As might be supposed, the *débris* thrown out of their workings were a means of calling the attention of travellers, as they have later guided the prospector to the existence of gold-bearing reefs in this country. But, as the ancients were unable to exhaust the veins they struck, so also were they unable to complete their discoveries of good surface outcrops. On every field since the arrival of the whites, excellent, and frequently very high grade, lodes have been struck bearing no vestige of former human prospecting or labour. Mashonalanders, as the new colonists call themselves, perhaps justly claim as a sign of the pre-eminent richness of their mineral rock, that in Zambesia alone cf old-world places have the old Eastern nations thought it worth while to delve upon a gigantic scale for the commodity whose value has been as old and long-established almost as the hills themselves. The districts now being worked are nine in number. With their distances from the chief city, Salisbury,* they are as follows:—

	Miles from Salisbury.
1. Umfuli (Hartley Hill, Umswesivi, Mombe, Concession Hill, Eiffle, &c.)	40 to 70 W.
2. Victoria (Fernspruit and eastward to Shashi' and Matabeleland	160 S.
3. Mount Darwin	100 N.
4. Mazoe (including the Anglo-French series)	30 N.
5. Salisbury (Upper Umfuli, Borrowdale and Enterprise series)	10 to 20 N., E., and S.
6. Northern (Lo Magondi, Angwe)	70 N.W.
7. Abercorn	70 N.E.
8. Umtali (Manica and Western Belt)	100 to 150 E.
9. Bandisi (between Umtali and Gazaland)	150 S.E.

Of the general character of the reefs the words of a well-known specialist, Mr. Robert Williams, will have more weight than anything that can be said by a mere layman in matters mineralogical. Speaking at the banquet given in Salisbury on St. Andrew's Day, 1892, Mr. Williams said: "There should have been no such mistake" (as that made by the first experts, who came and, after the manner of their kind, condemned the country) "here, as the formation was similar to that of California, schistose. In Mashonaland there were at least five distinct belts of schistose rocks extending in almost unbroken parallels across the country for a distance of 400 miles, and equal to about 2000 miles of belt, varying in width from 7 to 20 miles. Beyond the Mazoe again there were other belts, which it would be modest to place an estimate of a thousand more miles on. Roughly, it might be said there were 42,000 square miles of gold-bearing country here—about two and a-half times greater than that in California. As to the old workings—and I have since coming here travelled some 4000 miles over almost continuous old workings—I roughly estimate that at least 800,000 tons of stuff have been excavated by the old diggers. Taken at the low estimate of 10 dwt., this would mean a value of £1,600,000. I think it more probable, however, that this excavated stuff ran as many ounces, for there was evidence that the old workers left such trifles as 10 dwt. reefs severely alone."

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* Situated about S. lat. 18°, E. long. 31°.

The properties Mr. Williams adopted for his Company have since gone far to bear out his expectations. Both the "Inez" and the "Dickens" have run over three ounces to the ton, and the "Vesuvius" and the "Alice" with small mills have assisted to prove that what attracted the ancients, was not a "dwt." reef, but one of ounces to the ton.

In different reefs, the gold occurs in widely different ways. In the "Inez," which assays exceedingly high, and runs from three to five ounces over the plates, little or no "visible" occurs. Generally, however, the quartz has very nuggety gold. "Shoots" are not unknown, though "pockets" practically are, in the mines as yet worked. Copper occurs in one or two rich lodes on both the Mazoe and the Victoria belts. Granite divides the belts, which, however, are rarely disturbed or approached by that primary formation.

The country lends itself admirably to cheap working: water, wood, and native labour, being procurable within the neighbourhood of every field, and, one might almost say, of every single mine. The much-talked-of fever is of a slight character, and by care, and such improvements as the planting of blue gums around the miners' houses, may be expected to disappear altogether in a few years. The cheapness of working was first proved by Mr. Henry Borrow, of Messrs. Frank Johnson & Co., who successfully developed and worked the "Salamander" property, at Hartley Hill, at a remarkably low expense.

In the powerful advantages, in the shape of climate, fertility of soil, and distinctness of geological formation, lay the answer to what seemed an inscrutable riddle, namely, how was it that the first trek into the country did not end in complete failure and ruin to the immigrants. Under almost every conceivable financial and social discouragement, the settlers held on, and they held on because the natural richness of the country was so evident to them that they felt fortune was but a question of pluck and perseverance.

Another reason why the country has been enabled to disregard the damning sentence passed upon it by the first experts and by the distinguished visitor, Lord Randolph Churchill, may be found in the wise government of the Chartered Company. Setting aside as debateable in the extreme either the merits or the demerits of the "50 per cent. clause," whereby the Company takes 50 per cent. of the promotion of a Mining Company, the rule of the Chartered Authorities and the powerful assistance of the Company's finance, has simply spelt salvation. With a *laissez-faire* government, or an obsolete type of rulers, such as has retarded the development of other South African States, there would not probably have been a battery brought into the country this year of grace, 1893. Fortunately for all concerned, the fates willed success to Mr. Rhodes' vast scheme, and Mashonaland has now some place in the thoughts of Lombard Street and Capel Court.

W. E. FAIRBRIDGE.

SALISBURY,
April, 1893.

APPENDIX XVI.

GOLD IN THE CAPE COLONY.

(*Taken by permission from Mr. John Noble's 'Handbook of the Cape and South Africa,'* 1893 *edition, p.* 44.)

NATIVE gold has been proved to exist in several parts of the Cape Colony; but nowhere has it as yet been found in paying quantities. In the Knysna district (S. lat. 34°, E. long. 23°) it occurs among the quartz reefs in the clay-slates, schists and sandstone, as well as in alluvial deposits. Between 1887 and 1891 a considerable amount of capital was expended by companies and individuals in developing and testing the auriferous area around Millwood, extending from the Karatara to the Homtini Rivers. During this period a total of over 2100 ozs. of gold was registered as won; but this was not sufficient to inspire hope or encourage more extensive workings. The development, carried out to a depth of over seventy feet, only proved the poverty of the reefs underground. The alluvial near the bed rock and at the bends of the rivers, worked by sinking pits and sluicing in a rough and ready way, was in some instances fairly payable. Two claims yielded 14 lbs. of gold in seven months' irregular working with ten labourers. Other portions produced little more than a few specks of gold. The average amount the alluvial yielded was about 8 grains per cubic foot of wash—a return not sufficiently remunerative.

In 1891, gold was discovered in the district of Prince Albert (S. lat. 33°, E. long. 22°), at two farms named Spreewfontein and Waterfal, in the Karoo, a locality where, some twenty years before, a nugget of 2 ozs. 3 dwts. had been picked up by a cattleherd. The gold was found chiefly as alluvial in the crevices of the shales and sandstones, traversed by thin veins or reefs of quartz, forming the bed rocks of the creeks and rivers. In some instances the hard matrix, in which the Saurian fossils common to the locality are found, was incrusted with cubes of iron pyrites carrying visible gold. From August to December over 500 ozs. were collected, including a number of small nuggets; but after a time digging was discontinued, it being found of an unpayable character. The total finds registered to the end of February, 1893, were only 738 ozs.

In 1892, alluvial gold of similar nugget form to that of Prince Albert was found near Kaboos, situate in the Richterveld, at the north-west corner of Namaqualand (S. lat. 29°, E. long. 17°). This tract had been prospected twenty years previously by Mr. Dunn, who reported having found traces of gold at various spots from Stinkfontein towards Missionary's Drift, on the Orange River. The formation is granite, gneiss, and quartz, with schists, sandstone and conglomerates, crossed by dykes of greenstone. This part of the country being extremely arid and void of food supplies, has as yet offered no attraction to the prospector.

Gold has also been found in pockets of prehnite varying from two to four feet in thickness, occurring in the igneous dykes near Cradock (about lat. 32°, long. 26°), and supposed to be derived from the sub-aerial decomposition of the surrounding dolerite rocks. At Laakenvley and Karoopoort, in the Ceres district, numerous quartz reefs occur, but the yield is only a few grains per ton.

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Besides the districts mentioned by Mr. Noble, gold has also been found on the northern bank of the Vaal River, close to the town of Barkly West, in conglomerate reefs bearing some similarity to the Witwatersrand formation.

APPENDIX XVII.

GOLD IN THE ORANGE FREE STATE.

(From the Johannesburg 'Star' of 21st March, 1893.)

THE expectation that payable gold-fields would be eventually discovered in the Free State seems at last to be within measurable distance of realisation. For several months past careful prospecting operations have been in progress in various localities immediately north and south of the Vaal River, and these have at length resulted in the formation of a syndicate to thoroughly prospect and develop six farms and 136 claims situate on the south side of the river.

The properties in all are about 21 miles in length, with an average width of three miles giving on the dips over one mile of ground, the reefs dipping only about 12 degrees. They occur in a range of hills situate about two miles south of the Vaal. On the southern side of this range the formation is intersected by five large bars of slate together with the same number of sandstone layers of reef parallel for a distance of at least 30 miles along the range, the formation having a slight dip to the north-west.

The reefs on it generally outcrop, but there are indications on the surface in the form of float matter and decomposed quartzite, showing the probable position of the reef, and no doubt whatever was left on the mind of Mr. P. Bennett, the well-known mine manager, who has lately inspected the property, that the reefs continue through the unprospected portion of the property and follow the same formation along the range for a distance of from 20 to 30 miles.

At the south-easterly portion of the property three reefs outcrop for a considerable distance, and a considerable amount of work has been done upon them. The hanging walls are of slate, and the float walls of sandstone. The most southerly of the three reefs is encased between slate and sandstone, and at a depth of twelve feet is twenty inches in thickness. It is estimated from pannings that 8 dwts. can be recovered from this reef over the plates. The Middle Reef is distant from the one just mentioned about 40 or 50 feet. A shaft has been sunk upon it to a depth of 40 feet, and the prospects are from 5 to 7 dwts., besides a considerable amount of pyrites. The Northern Reef shows a distinct reef or leader 15 inches in thickness, and prospects from 8 to 10 dwts. of free gold.

In the two first-mentioned reefs, the banket is composed of conglomerate of quartz pebbles with quartzite cement. In the Northern Reef the banket is larger, and contains darker pebbles than in the other reefs. It has a great similarity to the South Reef of the Main Reef series on the Rand. In the opinion of Mr. Bennett these reefs will eventually prove to be the southern portion of the so-called Main Reef series of the Witwatersrand.*

The facilities for mining are exceptionally good, there being quantities of wood in the district, and coal mines in the vicinity. Native labour and food are also cheap and plentiful, and the local conditions as regards water-rights and battery sites are everything that could be desired. As is well known, the laws of the Free State are much more favourable to the owners of property in respect to mineral deposits than are those of the Transvaal.† So much work has been already done that Mr. Bennett has no hesitation in advising that a ten-stamp battery should be at once erected for the purpose of thoroughly testing the ore on the various portions of the property.

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* Compare Appendix XIX., p. 197.

† In the Free State the owner of the soil has the right to the minerals, while in the Transvaal this right is vested in the State.

Thirteen assays have been made from carefully selected samples taken from the different properties above referred to, and the average result is 19 dwts. 12 grains. Some of the assays were made at the Bank of Africa, and others by the Crown Reef assayer.

It is proposed to syndicate the options which have been acquired over the above properties for £50,000, on terms which will provide ample capital for the thorough exploitation of the different farms.

The hope that mineral wealth would be found on the south side of the Vaal has risen more than once to the lips of our friends in the Free State, but up to the present time has always been dashed away. In the present instance, however, there is good reason to believe that permanent and payable reefs have been struck, and under the encouragement which the Free State Government will no doubt extend to those who have the enterprise in hand, it is not too much to expect that the Free State Fields will be a valuable reality producing gold in considerable quantities, before the end of the present year.

APPENDIX XVIII.

GOLD IN ZULULAND. THE VRYHEID BANKET GOLD FIELDS.

By J. T. CARRICK, PH.D.

ALTHOUGH gold has for years been known to exist in Zululand, and has actually been mined and milled at the Insuzi and Nondweni fields, the fact has never aroused a tithe of the interest and excitement that has been created in Natal by the operations at present being carried on by the Denny-Dalton Syndicate and others, in the Vryheid district of the Transvaal, immediately on the borders of British Zululand. The great feature of interest in connection with this new field is the fact that it is a Banket field, identically similar in formation to that of Witwatersrand, and, from the tests already made, of apparently equal richness.

To Natal, the future of these fields is of supreme importance. No one knows better than the average Natalian that a payable banket gold-mining field is no evanescent flash in the pan, but a steady, reliable industry that unites in itself the reliability of coal mining with the immense possibilities of gold mining.

Johannesburg stands to-day a monument to Banket. The stone which the mining wiseacres despised in 1886, has proved itself to be the head-cornerstone of South African prosperity, second in importance to no other mineral deposit, either in South Africa or out of it.

The story of Witwatersrand has been told already in this volume, and in such a manner that the least imaginative reader who has followed Mr. Reunert's narrative must have already recognised the truth of the above statement. It may be of interest then, before going into any detailed account of the new Banket Gold Fields, to acquaint the reader with how and when they were discovered, prospected, and finally succeeded in arousing the attention at present directed to them.

For many years previous to the Zulu War, it was well known that rich gold deposits existed in Zululand, but owing to the jealousy with which the Zulu kings regarded all prospecting, the mineral resources of the country remained absolutely undeveloped. Prospectors who, in the guise of hunters, attempted to search for the precious metals were politely informed that digging holes was not hunting, and as politely requested to "move on." After the acquirement by the Boers, in 1886, of the territory now known as the Vryheid district of the Transvaal, the difficulties in the way of prospectors were to a great extent removed, but owing to the rush to the Rand, it was not until after the collapse of the "boom" of 1888, that attention was seriously turned towards Zululand. All sorts and conditions of syndicates were formed in Natal to send all sorts and conditions of prospectors into the new Land of Promise. In the ways in which these prospectors went about their work some were wise and some were foolish; but in the main it may be safely said that the ways of the early prospectors in Zululand were not the ways of wisdom and experience. Companies were formed and reconstructed, and money was spent without any return coming in, until the hearts of the weary investors became sick with hope deferred, and they cried aloud in their bitterness that no good thing could come out of Zululand.

Among the many syndicates formed, there was one syndicate, composed of the late Sir Theophilus Shepstone and some friends of his in Pietermaritzburg, which has fortunately been instrumental in demonstrating that the croakers' estimates of the mineral resources of the country were anything but correct. Formed in the beginning of 1889, the first move made by this syndicate was to engage the services of a prospector, who from time to time reported the finding of gold-bearing beds on the farms now owned by the Denny-Dalton Syndicate. After six months' work, he advised his syndicate of the discovery, in a creek on the farm Tusschenbyde, of a much richer series of beds than any yet discovered.

Stripping operations were then begun and continued in a more or less desultory fashion for two years, when the beds were considered sufficiently exposed to admit of examination by a competent mining engineer. Mr. Furlonge, of Johannesburg, was the gentleman whose services were called into requisition, and in August 1891, his report was submitted to the syndicate in Maritzburg.

In his report, Mr. Furlonge declared that in all essential particulars the auriferous quartz conglomerate beds on the syndicate's property were identical with those of the Rand, and finally that the property was of such value, that it would compare favourably with many of the producing Rand properties. At the same time, however, the syndicate were warned that all future exploitation would only be of value if carried out by thoroughly competent men.

On the strength of this highly favourable report, Sir Theophilus Shepstone and his friends entered into negotiations with some gentlemen in London with a view to the formation of a Company with resources sufficient to thoroughly open up the new fields; but, owing to unfortunate experiences in Barberton, Johannesburg and elsewhere, the general feeling of the investing public was not at the time favourable to South African mines, and as a consequence of this, the negotiations were still hanging fire, when Messrs. Denny, Dalton, and Paulson visited the property with a view to purchase, in December, 1892. These gentlemen, being all men of experience, and possessing an intimate knowledge of the Rand Banket formation, at once realised the immense value of the banket-beds exposed in the creek, and as promptly decided to conclude all necessary arrangements for the purchase of the property.

While Mr. Denny set out for Pietermaritzburg to complete the negotiations for the purchase of the property, Messrs. Dalton and Paulson remained at the farm, and collecting all the tools they could lay hands on, at once set to work to open up the bed, No. 2, which offered the greatest facilities for development.

From the day on which Mr. Denny started for Pietermaritzburg to conclude arrangements for the purchase of the property, work began, and has been most energetically pushed on with ever since. By the beginning of April of this year (1893), nearly six hundred feet of the bed, known as No. 2, had been continuously stripped along its outcrop above the bed of the creek, and over one hundred assays had been made of this bed alone.

The farm of Tusschenbyde, on which these working operations have been carried out, has an area of about 1,300 acres. It is situated in the extreme south-easterly corner of the Vryheid district of the Transvaal, in what was formerly part of Cetywayo's territory. By wagon road it is about 90 miles distant from Dundee, Natal, about 120 miles from Pietermaritzburg, Natal, and about 140 miles from Durban, Natal. In a direct line it is about 85 miles from Pietermaritzburg, and 90 miles from Durban. Its elevation above the sea-level is from 3,000 to 3,200 feet.

Geologically, the farm forms part of the north-easterly slope of a ridge of hills which extends from the White Umvolosi River, at the base of the Inhlazatje mountain, on the north-west, to the White Umvolosi River on the British Zululand border, on the south-east. If the ridge of hills be regarded as a slightly bent bow, the White Umvolosi may be regarded as its string.

This whole slope is itself formed by the tilted-up edge of an immense sedimentary formation, of which the banket beds are an integral portion. The crest and south-easterly slope of the ridge are apparently of igneous origin, but, as these portions are entirely overlaid with diorite, it is impossible to say definitely whether this is actually the case. The diorite appears at many points to have come from a considerable distance, as it contains fragments of rocks which do not occur in the immediate neighbourhood, but there is at the same time no evidence to show that some portions of it at least have not been forced up through cracks in the immediately underlying sedimentary formation. Whether it has come entirely from a distance, or whether it has partly been forced up through cracks in the underlying sedimentary formation is really of little importance; the great point about its occurrence being the absence of any disturbing influence on its part on the sedimentary beds. At no point over the whole north-easterly slope of the ridge is there any evidence of eruptive upheaval. From one end to another the beds lie at about the same angle of 5° to 12° to the horizontal, and always in the same relative positions to one another; so regular, indeed, are the sections of the formation exhibited in the various creeks which flow in a north-easterly direction towards the White Umvolosi, that a description of the section of the formation as exhibited in the creek valley and creek bed on Tusschenbyde, is practically a description of what can be seen in at least a score of "dongas" and creeks, which occur along the north-easterly slope of the ridge.

On Tusschenbyde this north-easterly slope of the ridge has been hollowed out, partly by the action of what appears to have been at one time a stream of considerable dimensions, and partly by the present creek, with consequent formation of the present valley and creek bed, which may be described as a valley, about one mile long, half a mile broad, and two to three hundred feet below the general level of the slope of the ridge, with the present creek flowing from the crest of the ridge at the upper end of the valley down through the middle of it. For about half a mile the bed and banks of the present creek exhibit nothing but diorite in all stages of decay.

At the upper end of the creek valley there is in fact an immense Diorite kopje which seems by its formation to have blocked up the course of the stream that hollowed out the present creek valley. Coincident with the creation of this Diorite kopje there seems to have been a general overflow of diorite, as both sides of the valley are still to a large extent overlaid with masses of it, which can be plainly seen to be resting on the sandstone and conglomerate beds. Subsequent denudation has to a large extent removed this overflow diorite from the lower portions of the valley, but the process of its removal is not yet completed, and can in fact be most conveniently studied, not only in the bed of the creek, but also in the beds of several smaller streams which flow into the creek.

Flowing, as it does, down the dip of the sedimentary formation, the lowest layers of the formation are of necessity the first to outcrop in the creek bed. The first sedimentary layer which is shown in the creek bed is a coarse sandstone, with enclosed pebbles. This layer disappears under the overlying diorite at its upper end in the creek bed, its lower end being overlaid by another sedimentary layer in exactly the reverse manner to that in which the slates on a house roof overlie one another. If the creek bed be taken as the gently sloping roof of a house, the sedimentary layers of sandstone and conglomerate may be regarded as slates which have been placed so that the upper edge of the lower slate overlies the lower edge of the upper one. The layers succeeding and overlying the first coarse sandstone layer are also sandstone layers, but with the noteworthy feature that each successive layer is finer in grain than the preceding one.

About one hundred yards down the creek from the first sandstone layer the first banket bed (No. 1) is met with. Underlying it is a fine and rather soft sandstone layer, and overlying it is a layer of about 4 feet of hard, pyritic conglomerate, which assays about 3 dwts. all over. The banket bed itself is shown for about 20 feet on one side of the creek. At its highest point it is about 3 inches, at its lowest point about 2 feet thick; its actual thickness in the solid cannot be arrived at until it has been tested at a distance from the outcrop; there is every indication, however, that it will be from 3 to 4 feet thick. Being the softest portion of the strata it has been to a great extent removed by the washing action of the waters of the creek. As it is, it shows excellent results on panning, while the average of the assays made from it is 14 dwts. 10 grs. Although overlaid by a layer of pyritic conglomerate the bed itself is entirely free-milling at the outcrop. This is of interest as an instance of the permeability of the banket layers to the action of water and air. The same permeability to liquids which has made them at one time the main channels for the pyritic auriferous solutions, which impregnated them with pyrites and gold, exposes them now to the oxidising action of infiltrating water.

Overlying the hard, pyritic conglomerate bed already mentioned, there is still another bed of hard conglomerate, showing on assay from 1 to 2 dwts. of gold per ton. Above this, one layer of conglomerate succeeds another, each layer less like conglomerate and more like sandstone than the immediately preceding one. In the next quarter of a mile in the creek bed this gradual transmigration from conglomerate to sandstone is so complete that in the 20 to 30 feet of strata immediately underlying No. 2 banket bed there is not a pebble to be seen.

No. 2 banket bed occurs in exactly the same way as No. 1 bed. Below the banket bed is fine soft sandstone, while above it is hard, pyritic conglomerate. The fine sandstone on which it rests is the top layer of an immense series of sedimentary beds, of which No. 1 bed is the coarse pebbly bottom layer, and this is evidently the case with all the other beds on the farm. No. 1 bed is the coarse pebbly bottom layer of the series of sedimentary beds, on the sandstone of which No. 2 banket bed rests. No. 3 banket, which is met with further down the creek, rests on the sandstone layer of the series of beds of which No. 2 bed is the coarse pebbly bottom layer, and in the same way still another banket bed, No. 4, is found on the sandstone of the No. 3 series. On the top of the sandstone of No. 4 series there is a layer of jasperized slate, and further on, above this we find repeated layers of sandstone and slate which do not contain any further conglomerate or banket layers.

At the point where No. 2 bed outcrops the creek has made a cutting in the conglomerate and sandstone layers. This cutting is at its upper end about 90 to 100 feet, and at its lower end about 6 feet deep. The bed itself at the upper end of this cutting on the south side of the creek is about 70 feet above the creek level, and dips below the creek about 600 feet from where it begins, at the head of the cutting. Owing, however, to the construction of a road along the face of its outcrop in the creek the bed can only be sampled continuously for about 480 feet, the level of the road being at its lowest point, quite 10 feet above the water level. On the north side of the creek, the ground being lower than on the south side, a considerable portion of the bed at its upper end has actually been removed by denudation, but about 200 feet is still *in situ*, and exposed by surface stripping. At its outcrop on the south face the bed is only about 12 inches thick; it rapidly thickens, however, the average thickness for the first 150 feet being 20 inches. The average thickness of the following 300 feet is 33 inches. On the north side of the creek the average thickness of the bed is 37 inches.

Assays from the first 150 feet on the south face show an average of 8 dwts. 19 gr. per ton. The following 300 feet give an average assay value of 17 dwts. 16 grs. per ton. Where the reef has been cut into by cuttings, the average assay value of the pyritic ore (32 dwts. 6 grs.) is nearly twice that of the oxidized fringe of ore on the outside, which fact is evidently an indication that the average value of the reef as got from the oxidized ore on the outside is not truly indicative of the assay value of the body of the reef. Where oxidized, the reef material is extremely friable, and in taking samples there must be a considerable loss of the softest and richest portions. This can be proven, moreover, experimentally by taking a piece of oxidized ore and knocking it with a hammer over a pan; the dust that falls from the ore generally giving on panning a good show of gold.

Mr. Furlonge's estimate of the value of the reef was 24 dwts. to 25 dwts., and to use his own words, "this is a result which is not only very satisfactory, but one which I am safe in saying is very close to the truth."

Overlying No. 2, there are still two more banket beds, to which I have already alluded (No. 3 and No. 4). No. 3 is separated by about 90 feet of strata from No. 2, and No. 4 is separated from No. 3 by about the same thickness and the same character of rock. Both No. 3 and No. 4 contain gold, but apparently not in the same degree as No. 2 or No. 1: forming as they do, however, an integral part of the banket stratum, their existence as constantly auriferous beds over the whole stretch of 12 miles of country on the north-easterly slope of the ridge of hills, is a guarantee of the continuity of the other beds, which, to judge from the work already done on them, are evidently of enormous value.

With regard to the manner of the formation of these beds there are several points worth noticing:—

Firstly,—the sharp line of division between the banket layers and the underlying sandstone foot walls; in every instance the line of division between the coarse pebbly bottom layer of the one series, and the sandstone of the underlying series being as sharp and clear as it could possibly be. Secondly,—the remarkable fact that while the hanging wall is always more or less impregnated with gold, to a distance above the reef of 10 to 12 feet, the sandstone foot wall is in every instance absolutely barren. Thirdly,—the superior richness of the upper half of the reef as compared with the lower half.

These various characteristics of the reefs can only, in my opinion, be accounted for in one way, *i.e.*, by the theory—firstly, —that the successive sedimentary series were laid down with great intervals of time intervening between the deposition of each series, so that the mass of the preceding series, and consequently more particularly its uppermost portion, the sandstone, was hardened before the deposition of the succeeding series; secondly, —that the gold in the beds has been deposited by ascending auriferous solutions of carbonates and supersulphides, which have impregnated the strata with gold and pyrites in exact relation to its porosity; and, thirdly,—that the impregnation of the beds took place at a time when they had already been more or less tilted up from the horizontal.

In an inclined layer of porous stratum an ascending solution would of necessity deposit more particularly along the upper portion of its channel, and in such a manner that a layer of the substances being deposited by it would be found along the uppermost portion of the channel afforded it by the layer of porous stratum. This is what we should logically expect, and this is exactly what we find. All along the top of No. 2 bed there is an extremely pyritic layer, about 4 to 6 inches thick, and this layer is much the richest portion of the reef material. Such deposition could not have taken place along the course of a channel through which a descending current was passing, and with no current there would be no reason for a difference in the deposition between the top and the bottom of the channel.

By deposition, I mean, of course, chemical deposition, such as takes place when any substance in solution crystallizes out of that solution, by reduction either of temperature or pressure, or by reduction of both combined. In a solution descending into the bowels of the earth, both temperature and pressure would be gradually increased, so that to look for deposition in that way would be absurd.

Under conditions which offered rapid reduction either in temperature or pressure, we should expect a rich deposition of mineral in the line along which the pressure impelled it. We should expect a rich shoot to go down, more or less vertically, in the channel at a point where the channel presented a steep, or, in other words, a direct, ascent to the ascension of the depositing solution, and this is the general experience of the Rand.

Practically these conclusions are of great importance. If the auriferous solution came up through the banket layers after they had been tilted up, then we may naturally look for greater average richness the more we go down—average richness, not absolute certainty of richness at any particular spot. As part of the theory, we must presuppose original channels leading from the underlying igneous, auriferous strata to the banket layers; and should no such channel exist in the immediate neighbourhood of any particular spot, it is natural to expect that such a spot would be poor.

As far as the Tusschenbyde series of beds is concerned, this would all point to an extremely regular distribution of gold. Lying as they do at a gentle inclination from the horizontal, an even distribution of flow of the auriferous solution, and consequently an even deposition of gold in the banket beds, is to be expected. This, in conjunction with the probability of the reefs being found at a comparatively shallow depth at a great distance from the outcrop, justifies the conclusion that the new fields will prove of such extent and value that several generations must elapse before they will be worked out.

Coal of an excellent quality can already be delivered at the battery site on Tusschenbyde at 25*s*. per ton. Transport from the coast can be procured at £4 per ton; labour is plentiful and cheap, and the climate is exceedingly healthy; everything, in short, points to a prosperous future for the new fields.

To South Africa in general the success of the new fields means the creation of another wealth-producing centre, while to Natal in particular it means a lift such as she has not received since the origination of the Rand.

J. T. CARRICK.

LONDON, *July*, 1893.

APPENDIX XIX.

MR. HAMILTON SMITH'S REPORT ON THE RAND.

THE following report on the Witwatersrand Goldfields, by Mr. J. Hamilton Smith, the well-known American mining engineer, was published in London, in January, 1893:—

In 1886 gold was discovered in beds of conglomerate near the present town of Johannesburg, on the southern slope of the range of hills known as the Witwatersrand, which forms the dividing watershed between the Atlantic and Indian Oceans. The occurrence of gold in such sedimentary deposits was as unusual to miners as that in the Mount Morgan Mine before spoken of. There were no rich placers below the outcrop of these beds, their absence being doubtless due to the fact that the gold in the conglomerate (locally called " banket ") was in small particles, far more minute than the grains found in quartz lodes. A great rush was made to this " camp," mining companies were formed by the hundred, and prices of shares were run up in most cases to ridiculous figures. Hardly any of the original prospectors and mine-owners had any previous knowledge of gold-mining, so very poor mining and milling plants were the rule, but this did not matter so long as shares were going up by leaps and bounds. Instead of learning how to work the mines, the superintendents were busy on the Johannesburg Stock Exchange. Then the inevitable collapse came; the mines were unduly discredited; no more money was to be had from the pockets of the European shareholders; and the people of Johannesburg were left to work out their own salvation from the mines themselves. This, for the past two years they have industriously been doing, until at the present time many of the mines are paying dividends honestly earned. Such mines require costly and elaborate mining and reduction plants, coupled with economical and skilful management, and in these respects there is yet much room left for improvement; but the mine managers, almost without exception, now recognise their shortcomings and are anxious to improve their methods, so that in a few years I believe they will thoroughly master the peculiar conditions of their work, and in time most of the mines will be models of efficient management. In 1887 the product from the Rand was 35,000 ounces of gold bullion, worth about £120,000. Since then the yield has steadily increased, until in 1892 it was

1,200,000 ounces, having a gold value of about £4,250,000. In the opinion of those most competent to judge, it is highly probable that this yield will continue to increase until the product from this comparatively small district will exceed that from the whole United States, now the largest gold producer of any country, with an annual output of from £6,000,000 to £6,500,000. Russia probably ranks next, and then Australia. The Rand, in 1892, will rank as fourth, while, as will be seen hereafter, I believe the chances are that its product in three or four years from this will go up to over £10,000,000, and continue at this rate for a good many years to come. This probable great increase in the world's supply of metallic currency is of the greatest interest not only to economists, but also to the common business man; it is of importance to every member of all civilised nations.

The following statements are based upon my observations during a visit to the Transvaal in the past months of August, September, and October, 1892.

The country south of the Witwatersrand is a rolling and treeless tableland for a distance of some 36 miles to the Vaal River, the boundary between the Transvaal and the Orange Free State; Johannesburg being about 5600 ft. above sea level, and the Vaal 4300 ft.; to the south of the Vaal are gently ascending hills. The geological formation is a basin deposit of sandstone, which has been transformed, by heat and pressure, into a firm quartzite, but which, in nearly all cases, retains the planes of original stratification. In this quartzite are many beds of conglomerate, varying from a few inches to 20 ft. or more in thickness, the pebbles being generally of quartz; these beds appear to be "truly conformable," that is to say, nearly parallel with each other, and with the stratification of the quartzite. Through this general formation very many small dykes of greenstone occur, apparently filling original fissures in the earth's surface; running east and west, and nearly parallel at a distance of four or five miles from the northern margin of the basin, there is a huge dyke of amygdaloidal greenstone from two to three miles in width, which can be traced for a distance of more than 20 miles. The basin has a length east and west of say 50 miles; its northern boundary is roughly the Witwatersrand, where the outcrops of the beds of conglomerate are the most regular; on the eastern and western margins, the formation has been greatly faulted and twisted; the southern outcrop has not yet been determined; but it is probably in the Orange Free State, some miles south of the Vaal River.*

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* Compare Appendix XVII., p. 186.

The trough of the basin I conjectured to be fully 15,000 feet in vertical depth below the surface, and very likely much more. Its geological position is believed to be just under the carboniferous series, being about the same as that of the millstone grit in England and elsewhere; in fact, the formation closely resembles an English coal basin, only that the beds are of conglomerate instead of coal, and that dykes of intrusive rock are far more frequent.

Gold is said to be found in all these many beds of "banket,' but as a rule only in small quantities, except in two or more of the inferior (lower) beds, which are called the "main reef series;" the gold is found adjoining the individual pebbles, but not in the pebbles themselves, nor in the quartzite, nor in the occasional quartz lodes which traverse the district. Much prospecting work has been done on the upper and poorer beds, but at the present time I think only one of the many mines upon them is being worked at a profit, and in fact most of them have been practically abandoned; possibly as prices of labour, &c., cheapen, they may yield gold in considerable quantities; they doubtless contain many million ounces of gold, but the average value per ton seems to be too low for general working.

My studies were chiefly confined to the "main reef series" on the central and northern portion of the outcrop, including the mines between the "Langlaagte Block B." and the "Glencairn," and having an aggregate length of 58,500 feet—about 11 miles. Within these limits the formation is more regular than on any other portion of the many miles thus far traced on the margin of the basin, and from this section has come about two-thirds of the Rand's total product of 3,070,000 ounces of bullion to date. This 11 miles of outcrop is owned by thirty-six companies, runs nearly east and west, and the beds have a general dip of say 35 degrees to the south; there are many small greenstone dykes crossing at all angles, but which rarely disturb the adjacent "banket"; in the total distance of 58,500 ft. thus studied, perhaps 3500 ft. has thus been cut out by these dykes, and another 5000 ft. has thus far seemed to be too poor to work, so that mining has been confined to about 50,000 ft. in length, and generally upon two beds of the "banket" not very far apart; the average distance on the dip exhausted for this 50,000 ft. up to August 1st, 1892, I considered to be about 160 ft., the average thickness extracted and sent to the mills, about 5 ft., the number of tons (2000 lbs. each) crushed say 3,000,000, and the yield (making a reasonable though not large allowance for gold in tailings yet to be extracted) 1,910,000 ounces of bullion, containing £6,700,000 in gold. This is an average yield of 12½ dwts. per ton, and is considerably less than the results given by the published accounts of the various mines. Up to 1891 the tendency was to report a smaller tonnage than that actually crushed, in order to show a better yield per ton, but now there is a healthy rivalry between the various superintendents as to costs of mining and milling per ton, so that the present official reports give with fair accuracy the actual tonnage. For such a continuous length the foregoing record is unequal in the history of gold mining. There have often been mines of short length far richer than those of the Rand, but nothing approaching them has ever been seen so far as regularity and extent are concerned.

The future product of the Rand practically depends upon four things:—

1. Will the "main reef series" continue to great depths?
2. If they do, what will be their general inclination or dip, and to what vertical depth will it be practicable to work them?
3. What amount of gold will be found with increased depth?
4. On how large a scale can mining operations be conducted?

As to the first query, I think it is as certain that the beds will continue clear across the basin, although interrupted by dykes of intrusive rock, as is the case with seams of coal; some of the mines have already reached vertical depths of from 400 to 600 ft. without any notable change in the position or character of the beds. Boring by diamond drills shows the same uniformity to depths of from 700 to 1000 ft.,* and the general regularity of the surface stratification for three or four miles south of the district I studied is most noticeable. These facts impress one with the conviction that the "banket" deposits are remarkably regular.

In my judgment the second query can only be answered by a careful examination of the stratification of the surface rocks to the south of the outcrop. These, as a rule, show a general dip of about 35 deg. for nearly two miles, which gradually flattens until the great greenstone dyke before described is reached. I assume, therefore, with considerable confidence, that 35 deg. will be the general dip until such a depth is reached that the cost of mining will become prohibitive. Some experts have been of the opinion that there may be "step" faults, whereby the various series, after dipping down to considerable depths, are lifted up abruptly, but I saw no indications that this was probable. Others assume that the "banket" will become nearly flat at vertical depths of 2000 or 3000 ft.; but I also think that this view is not justified by the facts now known.* The depth to which it is practicable to work mines often depends upon the amount of water to be pumped; but, as in the Rand, coal for fuel is abundant and cheap, neither the cost of pumping probable flows of water, nor the cost of hoisting the ore, &c., is likely to preclude working at great depths. The interior heat of the earth, I think, is the chief element to be considered in this connection; this varies greatly in different parts of the world. At the maximum depth of 3300 ft. reached in the great Comstock lode the heat was almost unendurable, while at the Calumet and Hecla copper lode the temperature is not troublesome at 2800 ft., and a shaft is there now being sunk with a contemplated final depth of 5000 ft. The Dolcoath tin mine is the deepest in England, I believe, the lowest workings being some 2800 ft. below the surface, and the heat there is not excessive. Taking all the facts into consideration, I fancy it will be safe to assume that an average vertical depth of 3000 ft. can be reached on the Rand. With this depth and a dip of 35 degrees there would be an hypothenuse of 5200 ft., to be worked on the "main reef series" in this particular stretch of eleven miles.

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* Now to 2400 ft. See Appendix XX., The Great Borehole, p. 203.

The third question is, of course, the most serious of all, and the most uncertain, and to its elucidation I gave very careful attention. The croppings of the beds beyond doubt averaged a somewhat better yield for the first 20 to 40 ft. in depth than did the deeper ore, but this, I think, came from an artificial enrichment due to natural washing of the original croppings, and leaving behind in the present soft and oxidised surface a notable quantity of gold which had originally been *in situ* higher up. After a thorough study of this question, and comparing the yield from the various mines for the different years, I came to the conclusion that while the ore in some of the mines had become a little poorer, in others there had been a slight improvement, but taking it for all and all the general average yield had remained practically unchanged. A number of borings have been made, in some of which very rich ore was found at 700 ft. and upwards, but it would be dangerous to draw any general conclusions from such tests. The common opinion at Johannesburg has been that the "reefs," as they call them, improve in value with greater depth, but I failed to find any distinct evidence in support of this belief. On general principles, with such a great linear extent of croppings fairly uniform in gold contents, it seems highly probable that the gold contents will continue much the same to such a comparatively shallow distance as 5200 ft. upon the dip of the beds.

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* Much further evidence has been afforded by the Great Borehole. See Appendix XX., p. 203.

The laws under which mines are held in the Transvaal determine largely the answer to the fourth and last query; there "square" locations are granted, each claim being 150 by 400 Dutch ft., with a licence, payable monthly, for each claim. The possessor of a claim is entitled to work all the minerals underneath the limits of his boundary, but he has no rights or privileges to adjoining claims, which may be held by other locators. This is the same method as that followed under the old Spanish law in the Americas. In the United States an apparently fairer method was introduced, the locator of a vein having the right to follow it down to any depth, the boundaries therefore being only on the side lines. Although the latter law is theoretically more just, experience in the United States has shown that it has often given rise to most costly litigation owing to the difficulty of defining the lodes, and I feel satisfied that it would have been vastly better for the general mining interests of the country had the Spanish custom been followed. The first prospectors on the Rand had very little idea as to the true theory of the formation of the "reefs," and as a rule only located claims near their outcrop. These claims form the estate of the various companies now in most active operation. More active-minded men began to see that the beds were continuous and on a moderate inclination, and "pegged out" claims on the dip, until now claims have been located to a distance of more than a mile below all the chief producing mines. These lower claims are called "deep levels," and it is proposed to develop them by sinking vertical shafts until the "banket" is reached, and then to mine the ore just as an ordinary British colliery is worked. Already a number of these shafts has been started, and one group of capitalists proposes to expend £1,000,000 upon development and plant for these "deep levels." If these first deep shafts prove successful, and show that the theories I have attempted to develop are correct, then many more shafts will be sunk, and thus many new producing mines will be brought into existence. The coal, or iron, or copper, or diamond, or even silver miner has always to take into account the commercial side of the industry, and over-production is his bane. Gold is now the only material for which there is a practically unlimited demand, so that the Rand mine-owners begin to see that it is better for them to work their "banket" with greater vigour than they have been doing in the past; in other words, a gold mine is nearly twice as valuable if it can be exhausted in 20 years than were 40 years taken to produce the same gross yield.]

Supposing my belief in the uniformity of the beds and their gold contents to be correct, the mine-owner will be justified in erecting plants of a capacity before unknown in the history of gold mining. The question of profit is foreign to the purpose of this article; but as it is of importance to the question of product, it may be stated that 21 of the 36 surface mines especially examined by me are now being operated at a profit, and of the remaining 15 several bid fair to soon become profitable. This ratio of paying mines is sufficient to insure the working of all, and they will all assuredly be followed down in depth until the working costs exceed the yield.

Coming to the total quantity of gold which the Rand may be expected to yield, we have for the stretch of 11 miles particularly discussed a paying length of 50,000 ft., a probable thickness of fully five feet, and an inclined depth of 5200 ft. This aggregates 100 million tons, of which three million tons have been mined; the remaining 97 million tons, at an average of 12½ dwts. per ton, would yield 60 million ounces, having a gold value of £215,000,000. I do not think it at all unreasonable to estimate that the many miles of "banket" outside of this district of 11 linear miles will yield at least one-half of this amount, or, say, £325,000,000 in all.* This seems a huge figure, but it is by no means a wild conjecture, and the final results will probably exceed even this sum. The large State of California, with gold almost from one end to the other, produced only £230,000,000 in gold from 1849 to 1892. This fact gives one an idea of the richness of these few square miles embraced on the Rand.

With the active and energetic set of men who now have the industry in hand, and always supposing that the foregoing theories prove to be exact, in three or four years from now the producing power of the mines and their reduction works will, I think, be increased to an output of five or six million tons of ore per annum, with a gross yield of over £10,000,000. At this rate the available supply of ore, as conjectured above, will last for more than 30 years, and the world's yearly product will have increased from £19,000,000 in 1883 to, perhaps, £30,000,000 in 1897.

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* Compare p. 103, *ante*, where by a different method of calculation a not very different result is arrived at.

APPENDIX XX.

THE GREAT BOREHOLE OF THE RAND-VICTORIA GOLD MINES.—FAITH VERIFIED BY FACT.—THE MAIN REEF STRUCK.—VISIBLE GOLD.

(*From the Johannesburg 'Star' of 17th June*, 1893.)

FOR the past few days the eyes of all interested in the permanency of these fields have been turned, metaphorically speaking, towards the towering sheer-legs which all travellers along the Boksburg line must have noticed south of the Simmer and Jack and quite close to the railway. Nor is this concentration of attention to be wondered at when it is remembered that at that spot a small machine driving a diamond drill has been busily engaged in proving to the world that the gold-fields of Witwatersrand are bound to make this State the premier gold-producing country of the world. Now that verification of broadly stated facts has been publicly made, it will be interesting to consider broadly what Messrs. English, Tracey, and Beatty have accomplished as a result of their magnificent faith, and what are the logical conclusions to be deducted from the successful penetration of 2500 feet of barren strata to the one thin stratum which will yield faith her golden reward. On the 25th day of October, 1892, a Bullock's "Dauntless" diamond drill, giving a 1 $\frac{7}{16}$ inch core, started its journey through unknown rocks. It was guaranteed to drill up to 1600 feet—no further—and it was fondly believed by the instigators of this daring and magnificent venture that it would attain the desired stratum when, even if not before, this depth had been attained. It is difficult to imagine the feelings of those interested in the venture when the guaranteed depth had been attained; it is still more difficult to imagine how doubt must have nearly swamped their faith, as each additional hundred feet was laboriously penetrated without a sign of success, and with the additional anxiety that the plucky little machine, already overstrained, would fail beneath its superadded burden and the toil of months be stultified in a single moment. But inch by inch, and foot by foot, depth was added without overwhelming disaster occurring, and the result has been that at 2343 feet the wished-for goal has been attained and the permanency of the Witwatersrand banket beds established beyond all doubt or cavil.

The inevitable pessimist has already been at work, however, with his bold but unfounded facts and figures, and as a certain section of the English press invariably follow the lead of these irresponsible detractors, it is as well that the other side of the question should be stated. The ground comprising the property which Lady Loch has so lately christened by the graceful name which will in the near future be probably as well known as Robinson or Langlaate, consists of no less than 402 claims. One portion, known formerly as the Salmon Syndicate, has 176, the other, Messrs. English, Tracey, and Beatty's block, 226. A large block of ground this, and a block that is situated in a locality already known as a rich and valuable one. As a matter of fact the Rand Victoria Mines include the deep levels of the Geldenhuis Main, and Estate, the Simmer and Jack, and the New Primrose, and although the depth appears at the first blush to be somewhat startling, as one at which gold mining can be profitably carried on, the fact is that the working depth has been over-estimated through want of additional data. The borehole is situated actually 1800 feet south of the northern boundary of the Rand-Victoria property, and thus calculations based upon the very exhaustive, though hardly conclusive, experiments made as to the dip of the strata passed through prove, with allowance for a 10 per cent. margin, that the main shaft which will be sunk upon the northern boundary aforesaid will not exceed 1200 feet in depth ere it strikes the same reef which the borehole has encountered, 1800 feet south, at an additional depth of some 1100 feet. This point is one which deserves emphasis, for it is hardly necessary to point out that the cost of such a main shaft to strike pay rock will be less than one-half what has been estimated to be necessary, assuming that it was sunk where the borehole is situated. And, moreover, so much are we indebted to the enterprise of the owners of the property, that one cannot refrain from adding a word of additional commendation on their labour, for it is obvious that had they been less enterprising their trial bore might very easily have been sunk upon the north boundary, and the vexed question of the permanency of the banket beds would have been 1100 feet further from practical solution.

The scientific interest attaching to this important work is considerable, and although a great many rapidly-drawn deductions may have to be eventually modified, our knowledge, mineralogical and petrological, has been very considerably enhanced. It will be noticed that a section of the borehole is given as nearly accurate as may be. Fuller details than can be there given, which Messrs. English, Tracey, and Beatty, aided by Mr. Adair, have carefully collated, show that the great mass of the strata passed through are sandstone-quartzites; there are some shales, some few schists and a very large number of layers of so-called reef matter, which vary from a true grit to what we know here as banket. There are curious inconsistencies in the cleavage of many of these rocks, which appear to point to some degree of unconformability; and throughout the whole series the dip varies with astonishing rapidity. But the theory as to the gradual flattening of the reef has been strongly supported by the newly-acquired information, the dip at the start being estimated as fully sixty degrees, while that at the bottom cannot be under-estimated at sixteen. If this gradual flattening continues it is quite possible that in a lateral extension of another few hundred feet, the bed will be horizontal, which would have a very important bearing upon working methods, and upon the value of those properties which have not the advantage of a steep angle of dip in their upper portions.

Before the rocks passed through can be properly classified it will be necessary to make microscopical sections, but they appear to be all simple petrographical studies as far as a cursory glance can teach. They are more highly metamorphosed apparently in the vicinity of the banket beds, and they also appear to alternate with each other much more rapidly as the true conglomerate beds are approached. Accessory minerals are talc, hydro- and common mica, glauconite, hydrated ferric oxide (which has, owing to its extraordinary similarity to gold, on more than one occasion raised the hopes of the prospectors to an Eldorado level), and copper and iron pyrites; the latter is present in many forms, occurring sometimes in scattered crystals, oftener in the thin partings, sometimes in solid homogeneous veins; often of a dull lustre, but as the Main Reef series is approached in crystals of splendent, even adamantine lustre. Such rough details as these may lay the foundation of much thought, which will eventually result in the acquisition of really valuable scientific information. But with us as a community the practical interest is the one which is of more concern, and it is no hyperbole to say that this small borehole has done more to build up the reputation of Witwatersrand than all the advertised efforts of the past. The assays of the main reef are not yet to hand, but when it is stated that 5 feet 8 inches of main reef have been passed through, that the footwall has not yet been reached, and that visible gold occurs in considerable quantity, one is absolutely staggered with the magnitude of the wealth in prospective. The South Reef where encountered has been assayed with the following results: the top portion gave 3 ozs. 8 dwts., the central portion gave traces, and the bottom 3 dwts. 12 grs. to the ton. This has been fairly computed to give an average result of 23 dwts. 12 grs.

per ton of ore, and the Rand-Victoria Mines have, at a moderate computation, 12 million tons of this ore alone. Take—as with our experience of banket we fairly may—this as a fair specimen of the results to be obtained from the Nigel to Randfontein, and the fabled Eldorado of Sir Walter Raleigh is but pinchbeck. Then again, when one considers that at this enormous depth of 2397 feet, we have not to deal with a densely pyritic ore, in which the precious metal is enveloped in a non-amalgamating cover, but with free gold in considerable quantity, the troublous problems of ore treatment sink into comparative insignificance, and leave us a clear vista wherein will be an output enhanced may be ten times, and whereon, not only our own, but the eyes of the whole world will gaze with appreciation and envy. We can now view with complacency the disquieting information afforded by the borehole that the Bird Reef series, where encountered, was comparately barren; it was and is, we think, never very rich anywhere, but the total absence of gold in it was, perhaps, disquieting. To-day we have the Main Reef yielding visible gold at a depth hitherto almost unknown, and we can only wonder without a particle of fear but with sanguine curiosity whether, when Witwatersrand is fairly at work —for now we know we are only on the fringe—we may not eventually raise a gold question which will overthrow cabinets and turn the political drift of a nation into channels undreamt of. Seriously speaking the news of to-day, although anticipated for some days past, is a practical illustration of what we shall do, and of what we are doing. It is a testimonial to faith and perseverance, those qualities without which no great enterprise, much less a great mining enterprise, can ever succeed. It is stated by Messrs. English, Tracey, and Beafty that the working capital for this great enterprise is not £100,000 as stated, but £200,000.

Details of the Core.

	Depth in Feet.
Surface soil and sandy blue clay	10
Small boulders in same	18
Friable shale changing to yellow clay, which hardened to rock at	98
A gradually hardening shale, blue in colour, and with undecided stratification	126
A three-inch quartz seam	138
Flagstone (?) of a greenish blue colour with a little lime	150
Blue shale, laminated, with occasional layers of metamorphosed sandstone: dip of strata here 60 degrees	167
A stratum of quartzite one foot wide	193
Blue slate with quartz pebbles	197
Three-inch layer quartz	220
Quartzite with few small pebbles, intermixed with sandstone layers	252
Sandstone layers	288
Ditto, with some pyrites and hydromicaceous seams	296

	Depth in Feet.
Pebble seam, three inches, in a series of vitreous sandstones and grits, all much metamorphosed	303
Beds of banket matter (?), probably coarse grits	333
Vitreous sandstones and quartzites, and commencement of Bird Reef series	337
The Bird Reef series of banket beds, consisting of alternating strata of barren banket and sandstone, dip here 50 degrees, to	366
Sandstones	367
Pyritic Banket Reef	368
Average dip of footwall here 50 degrees. A further series of sandstones, grits, and seams of banket, with hydromicaceous partings, until two reefs each 6 inches thick are encountered at 384 and	385
Four foot banket bed	389
An 18 inch banket bed	391
A 3 foot banket bed	405
A series of quartzites with some grits, terminating in a pyritic quartzite with some stray pebbles, the average dip of the strata being 50 degrees, at	426
Highly vitrefied sandstones and quartzites	427
A series of hard blue quartzites, having an average dip of 47 degrees	440
Reef matter, giving blank pannings	479
Fine grained sandstones, with few small pebbles, some small grit seams, and having a dip varying between 30 and 40 degrees	508
A fairly well defined reef, but barren	548 7 in.
An immense series of hard blue quartzites, with some sandstones, frequent seams of grit, or reef matter, a few layers of white quartz and occasional stray pebbles, terminating in a 21 inch barren reef at	915
Another large series of a similar nature to the last but with the dip increasing up to 45 degrees again, and terminating in a reef, barren, but one foot wide at	1127
A similar reef at	1152
Another similar series of quartzites, vitreous sandstones and grits	1153
Intensely hard gray shale with a somewhat conchoidal fracture dipping at angle of about 45 degrees	1529
Medium dark gray quartzite	1580
Very pebbly strata	1582
Green pyritic shale in seams of a pebbly quartzite	1590
A few inches of barren banket in a coarsely pebbled quartzite	1594
Coarse quartzite with very few parting seams	1598
A one-inch seam of solid pyrites in quartzite, the dip being 44 degrees	1605
A one-and-a-half-inch of a dark micaceous shale	1607
A series of curiously varying quartzites, some coarse and gritty, some schistose	1614
A pyritic banket bed	1635
One foot of banket, which contains gold, and is said to belong to the Livingstone series	1637
Dip 27 degrees at	1638
A series of 6 banket seams, nearly all blank, and when gold is found in but minute traces commencing at	1642
And terminating in a quartzite at	1667
Coarse and fine quartzites, with pale-coloured bands, dipping on an average 23 degrees	1668
Another large series of quartzites of all degrees of fineness, from almost perfect homogeneity to a coarse grit; sometimes hydromicaceous, sometimes schistose, and occasionally almost transparent; average dip about 22 degrees, terminating at	1860
Three feet of an undefined rock, which crumbled away, the core being thus lost, probably a hydromicaceous schist	1860
A series of fine schists with some small seams of very small pebbles	1878
A continued series of the same, with more frequent thin bands of conglomerate, the dip of the strata being as low as 13 degrees	1913

	Depth in Feet.
Distinct bands of pyrites and pyritic partings	1973
Pyritic partings, with curiously deceptive grains resembling gold, having the lustre of tin chloride, and really formed by hydrated ferric-oxide	1977
A further series of schists and quartzites, with some white quartz veins and frequent stringers of conglomerate the pebbles being from an eighth to a quarter inch diameter	1978
Dark grey shale, with white quartz and pyrites streaks	2027
Quartzites, and more frequent thin seams of conglomerate (banket)	2028
Scattered pebbles	2040
Five-inch white quartz vein	2047
A further series of quartzites, less schistose, but containing frequent beds of conglomerate	2048
Mottled quartzites	2092
Distinct pyrites bands	2095
A series of pyritous conglomerate seams, with frequent seams of pyrites, and very pebbly strata throughout	2096
Joints of pyrites	2163
White quartz 4 inches	2167
One inch of solid pyrites	2173
Pyrite crystals scattered throughout the strata	2204
Dip of strata average 15 degrees	2205
A series of very pebbly strata of quartzites	2206
Eight inches of banket, with ¼ inch pebbles; the outside fringe of the Main Reef series	2277
THE SOUTH REEF	2343
THE MAIN REEF	2397

Since the above was published, the foot-wall of the Main Reef has been struck at a depth of 2401 feet, giving an average assay through the 4 feet of 1 oz. 15 dwts. The Main Reef Leader (?) 18 inches wide, was struck at 2391 feet, and assayed in some samples as high as 10 oz. per ton, showing visible gold. The bore was still proceeding, and had reached a depth of 2425 feet. The flattening of the strata with increasing depth averaged about 1 degree for each 100 feet. The length of Main Reef "backs" that may be taken as proved from the point where the reef is struck in the hole, to the outcrop in the Simmer and Jack claims, is 4750 feet, so that the Witwatersrand Reefs may be fairly expected to be within reach of practicable mining for at least a mile south of the outcrops.

APPENDIX XXI.

THE CYANIDE PROCESS.

HISTORY OF THE MACARTHUR-FORREST PROCESS OF GOLD EXTRACTION.

By JOHN S. MACARTHUR.

THE writer became acquainted, about ten years ago, with Dr. Robert Forrest and Dr. William Forrest, two brothers in medical practice. At that time and for a dozen years before he was engaged in the Chemical Department of the Tharsis Sulphur and Copper Company. Along with the Forrests several researches on various branches of chemistry were made, including the chemistry of explosives, preservation of food-stuffs, &c.

About this time the writer became interested in photography, and very soon took the opportunity of making a close study of the chemistry of the toning solution which, as is well known, consists essentially of a salt of gold. The knowledge and experience gained in the laboratory of the Tharsis Sulphur and Copper Company were very useful in this study, especially as in the ordinary course of work it had fallen to him to make investigations on liquors, produced largely in the wet process of copper extraction, and which frequently contained a minute proportion of gold.

Towards the end of 1885, the writer and his partners received several samples of refractory gold ore, which put them in a good position for doing experimental work with a view to simplifying and cheapening the known methods for the recovery of the precious metal. Early in 1886, the public interest was aroused on the method of gold extraction proposed by H. R. Cassel and its merits were keenly discussed.

The researches of the scientific partnership brought prominently before them the outstanding fact that gold in refractory ores is generally combined or associated with compounds of base metals which possess the same general characteristics as gold itself of solubility in all well known solvents, such as the various compounds of chlorine and bromine. At this stage the writer contributed an article to a scientific weekly which attracted a good deal of attention, owing to the public interest in the subject at the time, and which ultimately led to his receiving the appointment of Technical Manager to the Cassel Gold Extracting Company, Limited, which Company had been left in difficulties owing to the sudden resignation of Mr. H. R. Cassel. The work was carried on, having the leading idea that it would be possible to interpose a chemical barrier between the chlorine and the base metal compounds which would not interfere with the action of the former on the gold or gold compounds. This method was, to a large extent, successful, but not sufficiently so to make it a commercial success.

Prior to his appointment by the Cassel Company the writer entered into a formal partnership with the Drs. Forrest and a fourth gentleman, who attended to the commercial aspect of affairs, while the other three confined their attentions specially to the scientific aspect. This syndicate of four members was expressly constituted for making researches on gold ores and gold extraction, and having equipped a laboratory and engaged an assistant, the researches were pushed with all vigour, so that by the autumn of 1887, they were in a position to review a year's work, involving the use of many reagents, and the elucidation of many reactions. This review led to the further investigation of cyanides as a class of solvents for gold as contained in ores. Experiments conducted with cyanide solution nearly a year before had successfully extracted the gold from tailings, but circumstances led to these results being for the time set aside. Further researches in the same direction, however, led them up to such practical certainty of the process being a commercial success that, in 1887, the inventors deemed it prudent to protect their discoveries by patents.

The difficulties in the way of precipitation had been very considerable—no ordinary precipitant of gold, such as sulphuretted hydrogen, oxalic acid, or sulphate of iron, will precipitate gold from a cyanide solution, therefore some new action or agent had to be evolved.

From the beginning the inventors knew that metallic zinc would replace gold in a cyanide solution, but the chemical reaction in this case was so feeble that it could not be employed under any ordinary circumstances. The only industry in which solutions containing cyanide of gold had to be manipulated was that of electro-gilding, and in that industry the use of zinc as a precipitant was unknown, the usual method in use being to boil the cyanide solution to dryness and fuse the residue in a crucible, when a button of gold would result.

Besides this, the cyanide solutions resulting from operations on the ores or tailings were much weaker in gold than those resulting from electro-gilding, consequently more economical means had to be devised. It is well to note here that in all the investigations and researches the inventors were careful to distinguish between the properties of metallic gold and the properties of gold as contained in ores. It is almost unnecessary to point out to the gold miner that the qualities and properties inherent in sovereigns and gold leaf are hardly those to be expected in a good sample of pay rock. Various precipitating agents, such as sodium, sodium amalgam, and electricity, were tried, but were not considered as good as finely divided metallic zinc. The zinc was used in the form of granules and shavings, and eventually preference given to the latter, which, so far, has held the field as the most effective precipitant for gold from cyanide solutions. It has the merit of simplicity in preparation, efficiency in operation and economy. It has also the draw-back that the resulting gold being in a fine powder is liable to contamination from the zinc itself and the metals generally associated with even the best brand of zinc. This involves a little more trouble and labour in the ultimate refining of the gold, when compared with the very easy retorting and smelting of amalgam.

In carrying out the MacArthur-Forrest process several precautions must be observed. The ore (for the sake of brevity, I shall always speak of "ore" as including ores, tailings, concentrates, &c.) should neither be too coarse nor too fine. If too coarse, the cyanide cannot penetrate. If too fine, it impedes lixiviation very seriously. The ore should not be acid, otherwise a quantity of cyanide is apt to be absorbed, or dissipated without doing any useful work. When acid it should be washed with water to remove, in the first place, all soluble acid compounds, and finally treated with alkaline solution such as caustic soda, or with lime, to remove the last traces of the acid compounds. It is well known that these compounds are almost invariably formed by the action of the weather on surface ores and exposed tailings.

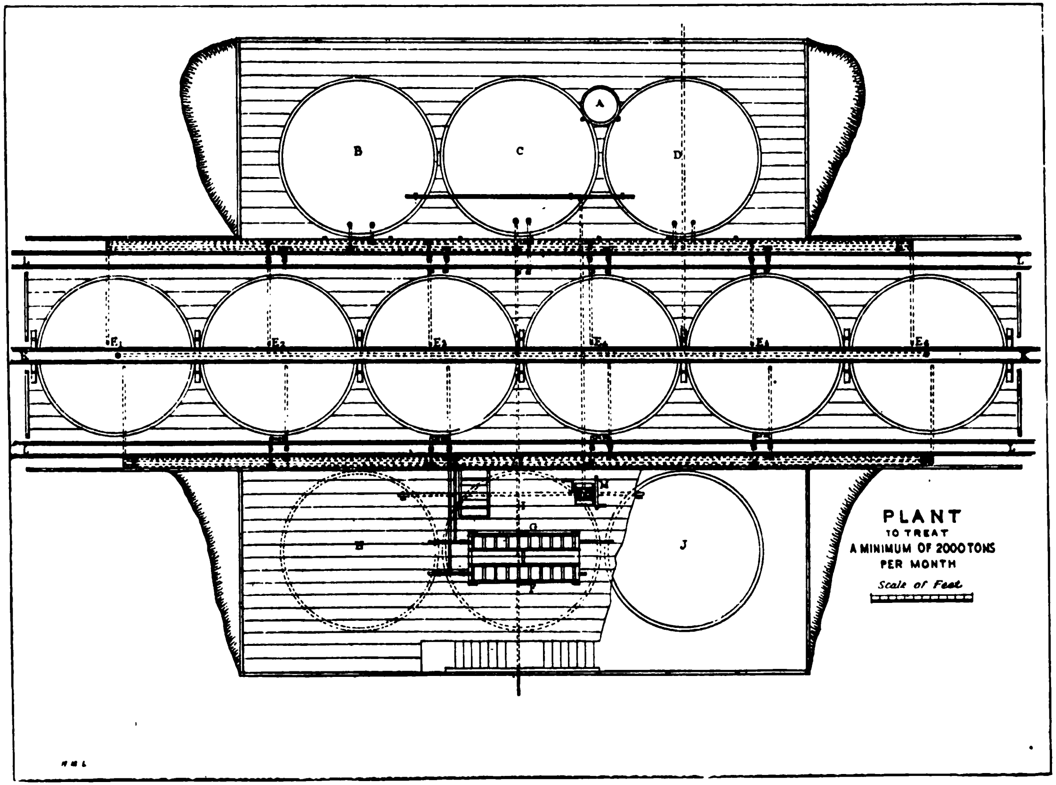
After being satisfied that these preliminary conditions are right, the ore is placed in vats, provided with a false bottom covered with canvas or other similar material to act as a filter, and treated with the cyanide solution, which generally contains cyanide equal to 0·6 per cent. of cyanide of potassium, by downward percolation. The cyanide solution may be caused to percolate either from the top or the bottom, or from one after the other. If the ore is inclined to clog, it is a good plan to percolate the solution from the bottom upwards, and then let it pass out downwards. The upward percolation keeps the ore more open, as it is obvious that the continued process of downward percolation must tend to beat the ore into an impervious mass, whereas the upper percolation has a tendency to act against gravitation, support the particles and maintain them in their original relative positions to each other. When ores are rich the alternate upward and downward percolation may be advantageously repeated several times over until the gold is extracted. In the case of poor ores and tailings the total time of lixiviation and washing occupies seldom less than thirty-six hours, which time is often increased in richer ores or when the material is coarse. The gold-bearing solution, as it comes from the vats, is caused to flow through a tank containing vertical divisions so arranged that the solution is caused to percolate invariably upwards through successive layers of spongy zinc. It has been found better that the percolation should be invariably upward, as otherwise the precipitated gold, which is always in a fine slimy powder, would, if precipitated on the top, prevent any further downflow, whereas, with the upward flow, the precipitated gold slime tends to fall and remain below the zinc. The precipitation goes on continuously and is only interrupted once or twice a month for a clean up. Every morning, however, the zinc is renewed as far as necessary by changing the partially corroded zinc from each division to the one immediately above it and placing fresh zinc in the lowest division. By this means the zinc is gradually and equally exhausted and replaced by the gold, for it must be borne in mind that for every ounce of gold deposited there is a corresponding amount of zinc dissolved. The amount of zinc actually consumed is not capable of calculation according to strict chemical equation, but generally amounts to ten or fifteen times the weight of the gold deposited. At each clean up the gold is shaken off the zinc and, passing through the gauze at the bottom of the division, gathers in a channel underneath, from which it is collected. The wet gold-slimes contain a large quantity of base metal which would be removed either by purification with acid before the smelting, or by oxidising the slimes and mixing with suitable fluxes. In smelting, the fluxes generally used are sand, soda, fluor spar, and borax. The smelting is done by fusing the mixture of slimes and fluxes in a salamander or plumbago crucible by the heat of an ordinary wind furnace. The operation somewhat resembles the fusion of brass in a brass-foundry. Care should be taken to prevent an unnecessary amount of base metals accumulating in the slimes, because of the trouble involved in their removal. The bullion resulting from ordinarily good work should contain less than 5 per cent. of base metal.

The accompanying illustrations show convenient disposition of plant and also a detailed drawing of the Extractor-box.

JOHN S. MACARTHUR.

GLASGOW, 27*th June*, 1893.

PLATE I



PLAN OF CYANIDE WORKS.

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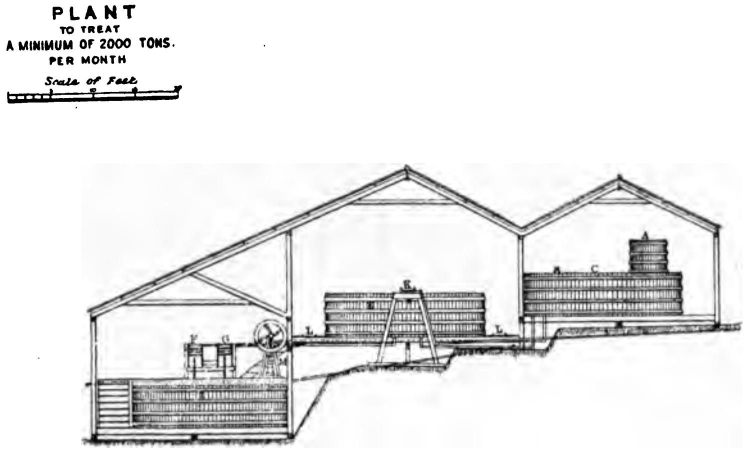
PLATE II



ELEVATION OF CYANIDE WORKS.

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Plant to treat a Minimum of 2000 Tons per Month.

Plates I. and II.

THIS plant is designed to treat the crushed ore or tailings by percolation with cyanide solution, and is the usual arrangement for ores of average grade.

From 2000 to 3000 gallons of water used per day.

Labour required—about 8 men per shift of 12 hours.

In many cases, much of the piping shown in the sketches may be replaced by wooden launders, effecting a considerable saving in the cost of the plant.

A	Cyanide dissolver containing stock solution.
B	Spare vat for alkali solution, &c.
C	Strong solution, storage vat.
D	Weak do. do.
E_1, E_2, &c.	Ore vats.
F	Strong solution zinc box.
G	Weak do. do.
H	Spare sump for alkali solution, &c.
I	Strong solution sump.
J	Weak do. do.
KK	Charging tramway.
LL	Discharging tramway.
M	Pump for raising solutions from sumps to storage vats.

The method of working this plant is somewhat as follows:—Two ore vats will usually be charged each day, thus, when vats **E_1**, **E_2**, **E_3**, and **E_4** are filled with ore in different stages of treatment, **E_5** and **E_6** will be ready to be charged.

The ore or tailings to be treated is brought in trucks (preferably side tipping) along the charging tramway **KK**. (The longitudinal beams of this tramway are supported upon trestles between the vats, and are trussed with iron rods to increase their strength. These beams must not rest on the ore vats, as the vibration caused by the trucks tends to loosen the staves of the vats and cause leakage. The trucks may be pushed by men or boys if labour is cheap, but it is often found economical, especially when working a large heap of tailings, to erect a small haulage drum, driven by a small steam engine or any convenient source of power.) Wooden slats, about 2 inches square, are fixed on the bottom of the ore vats (inside), and on these is stretched a filter cloth, upon which the ore rests. In many cases a special style of sand filter is being substituted for the cloth with very satisfactory results. This consists of a false bottom of angle iron bars with their angles upwards and their edges touching or nearly touching, supported upon distance pieces 1 inch from the bottom of the vat, to allow the solution free passage underneath it. The channels between the angle bars are filled with sand, which forms the filtering medium. In discharging the tanks, the men's shovels slide along the top of the angle irons without disturbing the sand bed. Triangular wooden slats may be substituted for the angle iron bars. Ordinary forms of sand filters are also in use. The ore is tipped from tramway **KK** into the tanks, and is spread evenly over the filter bottom by men with shovels.

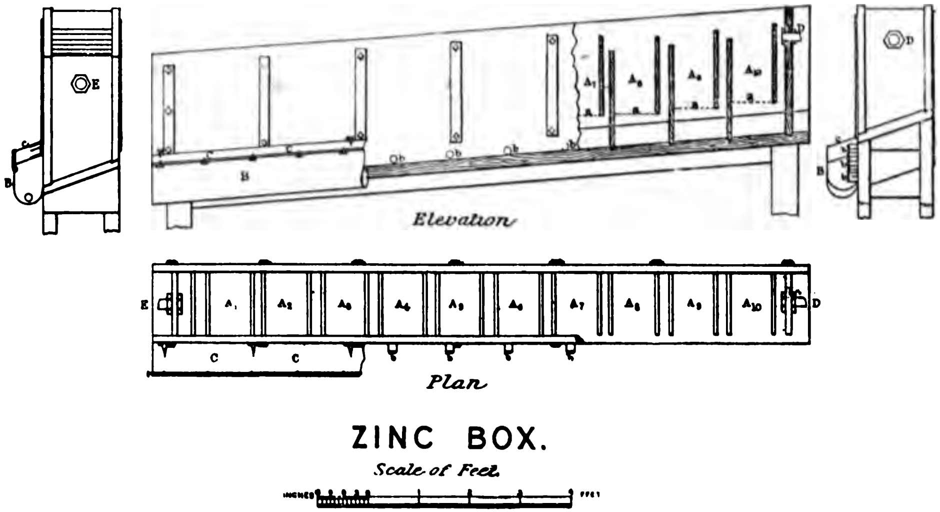
About 40 tons are charged into each vat, filling it to a depth of about 4 feet. The strong solution supply cocks are then opened, and the solution flows from vat **C** to the ore vats, in which it rises from the bottom slowly upwards until the ore is completely saturated, meanwhile dissolving its gold and silver contents. When the solution is a few inches deep above the ore, the supply cocks are shut and the draw-off cocks opened, which allows the now enriched solution to flow through the zinc box **F** to the sump **I.** (The solution is allowed to percolate slowly through the ore. The minimum time for the percolation and two washings is usually 36 hours, but no hard and fast rule can be laid down.) In working rich ore, percolation may be repeated several times with or without passing the solution through the zinc boxes each time. In the latter case, the spare sump **H** and spare storage vat **B** will be utilised. If this is impracticable, another sump and storage vat must be added.

The ore is then percolated with weak solution from vat **D**, which is allowed to rise through the ore in vats $\mathbf{E}_5$, $\mathbf{E}_6$, and then drained off and passed through zinc box **G** to sump **J**, in a precisely similar way to the strong solution. This is usually done twice, and a few inches of water is then run on the top of the ore (from the water supply pipe which runs along charging tramway **KK**), and then drawn off through weak solution zinc box **G** in the same way as weak solution.

After the last washing has been drained off, the spent ore is shovelled from the vats into trucks which run on tramways **LL**, and wheeled away to the dump.

The rich solutions are deprived of their gold in their passage through the zinc boxes, and are pumped back from the sumps, either to the strong solution storage vat **C**, there to be strengthened up with fresh cyanide, or to the weak solution storage vat **D**, to be used for washing as required It must be clearly understood that the terms "strong" and "weak" are

PLATE III.



ZINC BOX.

EXTRACTOR BOX FOR CYANIDE WORKS.

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only relative as applied to these solutions, as the so-called "strong" solution is generally under 1 per cent. strength of free cyanide, while the "weak" solution usually runs under 0·5 per cent.

The only really strong solution is that termed stock solution, which is kept in the cyanide dissolver **A**, for strengthening the liquor in tank **C** when required. This solution is made 10 per cent. to 25 per cent. strong. The cakes of cyanide of, say, 70 per cent. purity, are suspended in **A** in a wire gauze tray, and the dissolver filled with water which dissolves out the cyanide, leaving the insoluble matter, &c., on the tray.

The gold and silver are left in the zinc box in the form of a fine black slime, deposited on the zinc. When a clean up is made, the zinc shavings in the compartments $\mathbf{A_1}$ $\mathbf{A_2}$ &c. (Plate III.), are well stirred, which shakes the slimes to the bottom of the box; the plugs **bb** are then removed, and the solution remaining in the compartments $\mathbf{A_1}$ $\mathbf{A_2}$, &c., rushes into the gutter **B**, carrying the slimes with it. The slimes are then easily collected, and either roasted and smelted with the usual fluxes to a slightly impure bullion, or treated with weak acid to remove zinc; what remains is gold and silver with a small percentage of base metal, which is run into bars as marketable bullion.

Zinc Box for Large Plant.

Plate III.

THIS sketch shows a form of Zinc Box, designed to precipitate the gold and silver from 1000 gallons of solution per hour.

About 100 lbs. of zinc shavings is required to charge it.

To treat the total daily solution from a "2000 ton a month" plant, this style of box requires to run only about nine hours per day.

$\mathbf{A_1}$, $\mathbf{A_2}$, &c.	Compartments for zinc shavings.
B	Gutter for gold slimes.
C	Sheet-iron door of gutter.
D	Pipe supplying rich solution.
E	Pipe to lead away solution after treatment.
aa, &c.	Wire gauze bottoms of zinc compartments.
bb, &c.	Plugs for discharging gold slimes into gutter.

APPENDIX XXII.

THE TRANSVAAL SILVER MINES.

THERE are extensive deposits of silver in the country north-east of Witwatersrand, in which, at present, three mines have been opened up: the "Transvaal Silver Mines, Limited," the "Albert Silver Mine," and the "Willows Silver Mine," though only on the two former has any considerable amount of work been done, and before the end of the present year they will probably be in a position to arrive at a just estimate of the prospects of establishing a payable silver industry in South Africa. From the Transvaal Silvers, samples of ore, shipped to Europe two years ago in considerable bulk, contained seventy per cent. of lead, and ninety ounces of silver per ton. The Company then erected smelting furnaces, but subsequent experience has induced them to adopt the process of crushing and concentrating in preference to smelting, and a large Lührig plant is now in course of erection at the mine, under the superintendence of the new manager, Mr. E. Wertheman. The new works are calculated for a capacity to treat 100 tons of ore every shift of ten hours.

The Albert Mine lies about fifty miles to the north-east of Pretoria, and here also the ore has been treated by concentration. The farm Roodepoort, on which it is situated, is some 10,000 acres in extent, and is the exclusive property of the Company. "The journey for the greater part of the distance is along the old Delagoa Bay transport road. Just beyond the farm the bush-veldt commences, and wood for mining or fuel purposes is procurable at very low rates. As, however, the Company owns a coal mine distant only some eight miles, this is not so important a factor as would otherwise be the case; and coal of excellent quality, costing some 14*s.* per ton, delivered at the mine, is used for the engines. The farm itself is treeless, and the immediate neighbourhood presents a far from attractive appearance, judged from a picturesque standard. The mine is opened up in the centre of the farm on the south side of a gently sloping valley or creek. The creek itself furnishes an abundant and regular supply of water at all seasons of the year, and a small outlay on dams would insure a large conservation of water, if such were needed. The Albert lode consists of quartz, heavily impregnated with hæmatite or specular iron ore, which carries silver and copper in a variety of forms.

The lode is estimated to average ten to twelve feet in width, but in one place opened up, it bulges out to forty feet. The south foot-wall is of granite, but there is no hanging wall to the lode, the formation to the north being composed of an intrusive rock highly mineralized, which is 500 to 600 feet in width. Actual explorations with the diamond-drill have shown that this immense body of intrusive rock contains, on an average, six to seven ounces of silver to the ton, and, in some places, assays as high as twenty-seven ounces have been obtained from it. After passing through this intrusive body of ore, the granite formation on the north is reached. At present all practical work is confined to the ferruginous lode on the foot-wall, as sufficient data has not yet been collected to determine the payability or otherwise of the immense outside body of mineralized matter.—*See 'The Standard and Diggers' News,' Johannesburg, 28th January*, 1893.

APPENDIX XXIII.

THE WITWATERSRAND CHAMBER OF MINES.

THE Witwatersrand Chamber of Mines was founded in 1889. All mining companies and mining syndicates are entitled to join by simply notifying their intention to the Secretary and forwarding a cheque for the amount of their subscription. The membership is divided into three classes: companies paying one hundred and fifty guineas annually having the right to nominate three representatives; those paying one hundred guineas, two representatives; and those paying fifty guineas, one representative. Candidates for associate and foreign membership are subject to election by the executive body. Persons directly connected with the mining industry, such as mining engineers and individuals having interests in the mines, are eligible for election, subject to an annual subscription of three guineas; any one benefiting, or who is able to render service to, the industry may be elected an honorary member; and provision is also made for the admission of foreign members. The Executive is composed of the President, two Vice-Presidents, the honorary Vice-President (when a representative member), and the eleven members of the Executive Committee. This body carries on the work of the Chamber, but submits its proposals, before taking action, to the general meetings of members, which are held once a month.

The objects of the Chamber may be summarised as follows:—(1) the promotion and protection of the mining interests and industries of the South African Republic, and in particular those of the Witwatersrand Gold Fields; (2) the consideration of all questions connected with the mining industry; (3) the promotion of legislative or other measures for the benefit of the mining industry; and (4) the collection and circulation of statistics and other information of value to the industry and to persons interested in it.

The importance of the Chamber has been enhanced and its sphere of activity enlarged as a direct consequence of the political conditions of the country; and fortunately its objects as set forth in the articles of association were framed on so broad a basis as to embrace any subject which can be regarded as immediately or remotely affecting the mining industry. Under the constitution of the Republic, the franchise is limited to burghers; and even after naturalisation, it takes fourteen years for a foreigner to obtain burgher-rights and to become eligible for a seat in the first Volksraad. Lacking, therefore, direct representation in the legislature of the State, the mining community is compelled to appeal to the legislature through the Chamber of Mines.

Probably the most effective work achieved by the Chamber in connection with legislation has been the amendment of the Gold and Liquor Laws, and, in connection with departmental work, in the compilation and circulation of statistical returns, showing the production, and sources of production, of gold in the Witwatersrand district. But scope has also been afforded for its activity in battling against existing monopolies; in offering strenuous opposition to the granting of new concessions; and in dealing with the difficult question of native labour supply. In a young industry new circumstances are constantly arising which those concerned in it are alone able to appreciate and suggest the necessary legislation for. Legislation is obtained: (1) by presenting memorials to the Volksraad asking for amendments to existing laws; (2) by sending draft laws to the Government with a petition that they may be presented to the Volksraad; and (3) by submitting the views of the Chamber to the Government and requesting them to secure if possible legislation on the subject. In all matters the Chamber acts as the mouthpiece and the advocate of the industry.

Though the Chamber is a voluntary association without legal status, it is recognised by the Government, the Legislature, and the public, as the representative and mouthpiece of the mining industry. In this capacity it sends deputations and presents memorials to the Government, and through a member lays its petitions before the Legislature. It is also frequently consulted by the Government on matters affecting the mining industry, and seldom has reason to complain of its representations, made either in response to a request, or submitted on its own initiative, not receiving due consideration. It is now endeavouring to secure an Act of Incorporation.

Its representative character is maintained by the provisions for acquiring membership, and by the support given it by the mining companies; there being at present ninety-five members sitting in the name of fifty-nine companies in the Witwatersrand, and eight members for four companies in other districts of the Transvaal.

Each year the Report of the Chamber grows more voluminous as the subjects with which it is called upon to deal increase in number and importance, and the fourth Annual Report for the year ending 31st December, 1892, is in itself a striking illustration of the established status of the gold-mining industry of the South African Republic, and of the zeal and energy with which it is being fostered and developed by the men in charge of it.—*From notes supplied by the Secretary, A. R. Goldring.*

The tables which follow are mainly compiled from the valuable statistics published by the Chamber.

APPENDIX XXIV.

Value of Raw Gold exported from South Africa during the Years 1870–1892, inclusive.

Year.	From Natal.	From the Cape Colony.		Total Exports of Gold.
	£	ounces.	£	£
1870	250	Nil	Nil.	250
1871	370	11	43	413
1872	925	150	745	1,670
1873	935	22	85	1,020
1874	24,710	3,827	14,772	39,482
1875	28,443	11,327	43,009	71,452
1876	39,802	3,105	11,905	51,707
1877	14,115	14,095	54,030	68,145
1878	4,575	9,067	34,765	39,340
1879	1,100	7,611	29,115	30,215
1880	Nil.	5,855	22,450	22,450
1881	276	4,706	17,676	17,952
1882	6,865	4,230	15,175	22,040
1883	20,293	2,639	10,164	30,457
1884	16,708	7,232	22,297	39,005
1885	52,222	5,050	17,321	69,543
1886	113,166	6,674	23,914	137,080
1887	143,676	25,698	92,936	236,612
1888	391,643	151,770	517,821	909,464
1889	584,933	270,920	911,791	1,496,724
1890	358,520	436,434	1,497,455	1,855,975
1891	119,894	790,422	2,781,576	2,901,470
1892	333,117	1,164,940	4,095,512	4,428,629
Totals .	2,256,538	2,925,785	10,214,557	12,471,095

N.B.—The above figures give only the amounts as entered at the Customs, but it is believed they do not represent the total value of raw gold exported, as many parcels have been shipped or posted without being officially reported. No returns have been kept of the *weight* of gold exported from Natal. The above values include £32,452 value of gold exported from Natal to the Cape Colony.

APPENDIX XXV.

COMPARATIVE OUTPUT OF THE TRANSVAAL GOLD FIELDS IN THE YEARS 1890–92.

(Compiled from Returns published by the Witwatersrand Chamber of Mines.)

District.	1890.	1891.	1892.
	oz.	oz.	oz.
Witwatersrand	494,817	729,238	1,210,869
De Kaap	20,735	61,385	63,125
Lydenburg	14,315	23,903	24,092
Klein Letaba (Zoutpansberg)		7,926	14,694[*]
Klerksdorp and Potchefstroom	10,358	10,682	8,968
Malmani	..	..	2,061
Other Districts	..	..	1,585[†]
Total ascertained yield of the Transvaal	540,225	833,134	1,325,394
Total outside Witwatersrand	45,408	103,896	114,525
Total Weight of native Gold exported from Witwatersrand by the Banks	491,854	708,164	1,121,042
Total Weight of Raw Gold exported from South Africa [‡]	526,746	824,677	1,260,116

[*] Of this amount 13,618 ozs. 5 dwts. were contributed by the Birthday Company alone.

[†] Made up as follows:—

	oz.	dwts.
Marabastad	1,113	9
Houtboschberg	372	11
Vryheid	81	10
Silati	18	2

[‡] It appears strange that the total weight of gold *exported* from South Africa should be *less* than the ascertained *yield* of the Transvaal; but this is partly accounted for by a certain amount of gold being shipped or posted without being officially reported, or being retained in the country for minting or other purposes, and partly by the export returns being closed on the 31st December, while the production for that month is not declared until the 10th January; so that the full effect of the progressive output is not apparent from the export returns.

APPENDIX XXVI.

SHOWING THE PROGRESSIVE OUTPUT OF GOLD FROM THE WITWATERSRAND GOLD FIELDS.

(Compiled from Returns published by the Chamber of Mines.)

	1887.	1888.	1889.	1890.	1891.	1892.
	oz.	oz.	oz.	oz.	oz.	oz.
January .	..	7,328	25,505	35,007	53,205	84,560
February .	..	12,180	22,457	36,887	50,079	86,650
March . .	..	11,976	27,919	37,780	52,949	93,245
April . .	..	14,146	27,029	38,697	56,372	95,562
May . .	887	13,397	35,028	38,836	54,673	99,436
June . .	734	12,773	30,878	37,419	55,864	103,252
July . .	240	16,687	31,091	39,457	54,924	101,279
August .	1,409	18,616	30,520	42,864	59,070	102,322
September	1,936	20,242	34,143	45,486	65,602	107,852
October .	4,029	27,165	32,214	45,249	72,793	112,167
November.	5,463	26,827	33,722	46,783	73,394	106,795
December.	8,457	26,785	39,051	50,352	80,313	117,749
Total for each year	23,155	208,122	369,557	494,817	729,238	1,210,869

SUMMARY.

	oz.	
In 1887	23,155	
,, 1888	208,122	
„ 1889	369,557	
	42,000	Estimated as production of 1887–88–89, of which no record was kept.
„ 1890	494,817	
„ 1891	729,238	
„ 1892	1,210,869	
Total . .	3,077,758 ozs. = £11,000,000.	

The records of the three first years are imperfect. There were companies (since liquidated) and individuals working that during those years produced gold of which no returns exist; nor, although persistent endeavours have been made, has it been possible to ascertain with accuracy the quantity of gold won by them; and, besides this, prior to 1890, the Chamber did not obtain from the Banks particulars of gold received by them from sources other than those which sent in direct returns to the Chamber. The amount of 42,000 oz. has therefore been added, and as it is estimated as being well within the mark, it probably brings the total given above very close to the actual production for the first six years of these Fields.—See '*Fourth Annual Report of the Witwatersrand Chamber of Mines,*' p. 107.

APPENDIX XXVII.

ANALYSIS OF THE RAND OUTPUT FOR SIX YEARS.

(Compiled from Returns published by the Witwatersrand Chamber of Mines.)

Year.	1887.	1888.	1889.	1890.	1891.	1892.
	oz.	oz.	oz.	oz.	oz.	oz.
Lowest Monthly Output	240	7,328	22,457	35,007	50,079	84,560
Highest „ „	8,457	27,165	39,051	50,352	80,313	117,749
Average „ „	2,894	17,344	30,796	41,235	60,770	100,906
Increased „ „	..	**14,450**	**13,452**	**10,439**	**19,535**	**40,136**
Total Yearly Output	23,155	208,122	369,557	494,817	729,238	1,210,869
Increased „ „	..	**184,967**	**184,590**	**125,260**	**234,421**	**481,631**
Increase per cent. on previous Year	..	..	88	35	47½	66

APPENDIX XXVIII.

OUTPUT OF GOLD ON WITWATERSRAND IN 1892.—SUMMARISING TOTALS AND AVERAGES OF THE CHAMBER'S MONTHLY RETURNS.

Month, 1892.	FROM MILL.							From Tailings.	Alluvial Digging (Sluicing).	From Individuals and others not returning direct to Chamber.	FROM ALL SOURCES.	
	Tons Milled.	Number of stamps running.	Days Milling.	Tons per Stamp per Diem.	Yield of Gold.		From Concentrates.				Total Yield.	Total Value.
					oz. dwts.	dwts. per ton.	oz. dwts.	oz. dwts.	oz. dwts.	oz. dwts.	oz. dwts.	£
January .	119,049	1,560	26·21	2·21	70,637 8	11·04	1,930 1	9,692 2	170 0	2,130 8	84,560 8	300,005
February	119,068	1,610	25·26	2·91	72,080 4	11·67	2,344 10	10,366 2	200 0	1,658 12	86,649 8	307,267
March .	143,765	1,750	27·23	3·14	77,542 8	10·04	2,680 13	11,473 4	162 19	1,385 7	93,244 11	331,465
April . .	153,197	1,880	25·22	3·22	78,172 6	9·33	2,408 14	11,260 15	169 3	3,551 8	95,562 6	339,368
May . .	162,259	1,990	27·44	2·88	80,915 4	9·99	3,674 1	10,933 1	170 7	3,743 10	99,436 3	355,380
June . .	158,351	2,035	26·48	3·14	82,395 0	9·92	3,354 9	15,722 11	225 3	1,525 0	103,252 3	369,383
July . .	167,685	1,999	26·04	3·25	80,664 8	9·49	1,703 5	15,042 8	165 14	3,703 6	101,279 1	360,116
August .	174,170	1,955	26·23	3·51	81,257 2	9·16	3,995 6	14,208 12	104 10	2,756 13	102,322 3	361,855
September	179,915	2,029	25·54	3·58	85,431 18	9·29	3,285 9	15,263 18	113 14	3,756 14	107,851 13	379,750
October .	184,311	2,034	26·13	3·57	89,235 16	9·43	4,326 19	16,013 3	141 0	2,450 10	112,167 8	395,522
November	179,745	2,004	25·44	3·62	83,802 3	9·24	3,646 16	15,346 2	145 19	3,853 15	106,794 15	377,687
December	179,745	2,035	25·30	3·53	91,157 12	10·14	6,982 9	14,871 13	140 12	4,596 11	117,748 17	419,812
Totals for Year .	1,921,260	1,907	312·52	3·21	973,291 9	9·77	40,357 14	160,168 18	1,939 1	35,111 14	1,210,868 16	4,297,610

SUMMARY.

	Weight.	Value.
From Mill	973,291 9	£3,506,787
„ Concentrates . . .	40,357 14	157,656
„ Tailings . . .	160,168 18	502,408
„ Alluvial	1,939 1	6,877
„ Other sources . . .	35,111 14	123,882
	1,210,868 16	£4,297,610

(*See* '*Fourth Annual* (1892) *Report of the Witwatersrand Chamber of Mines,*' *p.* 116.)

APPENDIX XXIX.

List of Mines producing Gold on Witwatersrand during 1892

Mines producing over £250,000.	£	£
Robinson	486,003	
Langlaagte Estate	314,181	
		800,184
Over £100,000, and under £250,000.		
Crown Reef	246,944	
New Primrose	198,591	
Nigel	174,388	
Geldenhuis Estate	172,626	
Ferreira	170,416	
Simmer and Jack	138,905	
Durban Roodepoort	111,344	
City and Suburban	106,101	
New Chimes	102,573	
May Consolidated	102,409	
		1,524,297
Over £75,000, and under £100,000.		
Langlaagte B. Block	87,956	
Meyer and Charlton	80,258	
Jumpers	75,375	
		243,589
Over £50,000, and under £75,000.		
Salisbury	73,869	
Champ d'Or	70,874	
Glencairn	69,285	
Langlaagte Royal	65,940	
Jubilee	60,539	
Worcester	60,312	
Wemmer	59,544	
United Main Reef (Roodepoort)	61,452	
Stanhope	50,565	
		562,380
Over £25,000, and under £50,000.		
New Aurora West	46,828	
Main Reef	46,119	
Johannesburg Pioneer	42,840	
New Crœsus	41,680	
Wolhuter	39,279	
George Goch Amalgamated	38,447	
Orion	37,048	
Aurora	35,410	
Van Ryn Estate	31,801	
Henry Nourse	31,623	
Princess Estate	30,567	
New Rietfontein Estate	30,182	
Star	29,261	
Village Main Reef	28,624	
Metropolitan	27,403	
May Deep Level	26,937	
		564,049
Carried forward		£3,694,499

Brought forward		£3,694,499
OVER £10,000, AND UNDER £25,000.		
Paarl Central	24,322	
Treasury	24,298	
Randfontein	23,825	
Black Reef	21,468	
Roodepoort ("Kimberley")	21,286	
Nigel Syndicate (Tailings)	18,903	
Geldenhuis Main Reef	18,704	
Unified	16,918	
Langlaagte Western	15,956	
Meyer and Leeb	15,611	
Teutonia	15,068	
Langlaagte United	13,940	
Gipsy	13,101	
Rietfontein Estate	11,976	
Oriel	11,366	
		266,742
OVER £5,000, AND UNDER £10,000.		
Banket	9,221	
La Fortuna Syndicate (Tailings)	8,427	
Witwatersrand	6,899	
Modderfontein	6,219	
Nabob	5,138	
		35,904
OVER £1,000, AND UNDER £5,000.		
Fern	4,732	
New Heriot	4,169	
Black Reef Syndicate	3,081	
Evelyn	2,975	
Blue Sky	2,919	
Moss Rose	2,908	
Gardner Main Reef	2,792	
Late New Violet	2,741	
Bothas Reef	2,448	
Angle Tharsis	2,420	
Marais Reef	1,928	
Vulcan	1,660	
		34,773
OVER £200, AND UNDER £1,000.		
St. Albans (late Ida)	837	
Vogelstruisfontein	259	
		1,096
Total		£4,033,014

In addition to the above there was also derived—

From alluvial gold	6,877
„ ore reduction works	133,637
„ other sources	123,882
GRAND TOTAL	£4,297,410

(*Compiled from Returns published by the Witwatersrand Chamber of Mines,* 1892 *Report, p.* 110.)

APPENDIX XXX.

DIVIDEND LIST OF MINING COMPANIES ON THE WITWATERSRAND FOR 1892.

Company.	Rate per Cent.	Cash Distributed.	
		£	s.
African Gold Recovery Company	10	17,400	0
Aurora Gold Mining Company	5	3,250	0
Crown Reef do. do.	55	63,000	0
Durban Roodepoort do. do.	41	43,333	0
Ferreira do. do.	125	56,250	0
Geldenhuis Estate do. do.	10	17,500	0
Johannesburg Pioneer do.	50	10,500	0
Jubilee do. do.	60	17,502	10
Langlaagte Estate do. do.	20	89,400	0
„ Royal do. do.	35	19,500	0
Meyer and Charlton do. do.	45	30,083	0
Meyer and Leeb do. do.	12½	1,825	0
New Crœsus do. do.	10	7,500	0
New Aurora West do. do.	10	6,000	0
New Primrose do. do.	27½	47,731	0
New Chimes do. do.	40	20,048	0
Nigel do. do.	47½	75,989	0
Orion do. do.	7½	1,725	0
Robinson do. do.	7	190,312	10
Salisbury do. do.	30	27,900	0
Simmer and Jack do. do.	40	33,400	0
Stanhope do. do.	25	8,500	0
Treasury do. do.	35	5,250	0
Vogelstruisfontein do do.	5	2,090	0
Worcester Exploration do.	17½	15,875	0
Transvaal Coal Trust do.	5	21,348	0
Total	..	£833,212	0

KLEIN LETABA DIVIDEND LIST, 1892.

Company.	Rate per Cent.	Cash Distributed.
		£
Birthday Gold Mining Company	15	22,150

(*From the* '*Fourth Annual* (1892) *Report of the Witwatersrand Chamber of Mines,*' p. 109.)

APPENDIX XXXI.

SHOWING REVENUE AND EXPENDITURE OF MINING COMMISSIONER'S DEPARTMENT JOHANNESBURG, FOR YEAR 892.

Revenue.	£	s.	d.
By Import Duty	248,481	7	11
,, Transfer Fees . . .	21,044	12	9
,, Ground Leases . . .	1,234	10	0
,, Auction Dues . . .	2,705	0	8
,, Liquor Licenses . . .	24,689	10	0
,, Billiard Table Licenses . .	1,122	10	0
,, Bagatelle ,, ,, . .	5	0	0
,, Hotel Licenses . . .	807	10	0
,, Roadside Hotel Licenses . .	130	0	0
,, Bowling Alley ,, . .	12	0	0
,, Hawkers' Licenses . . .	1,635	0	0
,, Traders' ,, ...	345	0	0
,, Game ,, ...	62	0	0
,, Shop ,, ...	8,339	10	0
,, Bakers ,, ...	90	7	6
,, Butchers ,, ...	188	5	0
,, Chemists' and Druggists' Licenses	142	10	0
,, Boarding and Eating House ,,	961	12	6
,, Brokers' Licenses . . .	1,314	0	0
,, Bank ,, ...	750	0	0
,, Executors' ,, ...	150	0	0
,, Millers' ,, ...	70	0	0
,, Law Agents' ,, ...	845	6	0
,, Auctioneers' ,, ...	288	0	0
,, Land Surveyors' Licenses .	90	0	0
,, Mynpacht Fees . . .	367	10	0
,, Land Revenue . . .	878	5	10
,, Special Rights . . .	8,074	16	8
,, Pension Fund . . .	330	16	0
,, Passes and Sale of Stamps .	28,386	2	2
,, Gold Dealers	60	0	0
,, Brick Making . . .	957	5	0
,, Quarry	22	15	0
,, Poll Tax	2,897	0	0
,, ,, ,, Arrears . . .	67	0	0
,, Road Tax	728	17	6
,, ,, ,, Arrears . . .	18	10	0
,, Railway Tax	1,448	15	0
,, ,, ,, Arrears . .	45	0	0
,, Fines	6,439	18	9
,, Market Fines . . .	3,170	18	4
,, Pound Licenses . . .	41	10	2
,, Diggers' ,, . . .	10,707	10	6
,, Prospectors' Licenses . .	9,492	19	4
,, Stand Licenses . . .	13,575	10	9
,, Machinery Stand Licenses .	299	10	0
,, Bewaarplaatsen (Reserve lands)	771	7	8
,, Sale of Claims . . .	328	3	6
,, Tolls	6,162	14	4
,, Gold Depot Revenue . .	87	13	3
,, Weighbridge Fees . . .	3	0	3
,, Messenger's Fees . . .	1	1	0
,, Coolie Registration. . .	852	0	0
,, Naturalization Fees . .	235	0	0
	£412,346	0	5

Expenditure.	£	s.	d.
Half amount of Prospectors' Licenses paid to Owners .	11,148	0	0
Pass moneys paid to Hospital	4,790	0	0
Departmental Expenses — Salaries	4,150	0	0
Market moneys paid to Sanitary Committee . .	7,896	5	11
Sundry Payments . .	1,536	16	0
	£29,521	1	11
Balance clear profit to Revenue	382,824	18	6
	£412,346	0	5

The Postal and Telegraph Revenue is not included in the above, nor are the Returns for Boksburg, Florida, Krugersdorp, Doornkop, and Blaauwbank, which, however, though under *separate Commissionerships*, form, with Johannesburg, the Witwatersrand Gold Fields.

(See 'Witwatersrand Chamber of Mines' (1892) Report,' p. 117.)

APPENDIX XXXII.

De Kaap Gold Output, 1892.

[Compiled by Messrs. Chesterton and Steeds.]

Name of Company.	Total.		
	oz.	dwts.	gr.
Albion Gold Mining Company	136	10	0
Barrett's Gold Mining Company	1,293	14	0
Coetzeestroom Estate	1,876	9	1
Edwin Bray Gold Mining Company	2,507	10	0
*Forbes' Reef Gold Mining Company	3,421	1	3
Gipsy Queen Gold Mining Company	133	2	15
Gold Recovery Syndicate	2,344	0	0
*Horo Concession	2,297	10	0
*Havelock Gold Mining Company	46	0	3
Montrose	1,328	18	0
Moodie's Pioneer	2,270	15	10
Oriental and Sheba Valley	840	4	16
*Pigg's Peak	90	0	0
Sheba Gold Mining Company	37,185	11	21
United Ivy (Moodie's)	3,814	0	12
Union (Moodie's)	190	11	0
Virginia Estate	398	7	0
*Wyldsdale Gold Exploration Company	681	10	0
Syndicates (Moodie's)	2,100	19	2
Do. Government Ground	4,837	40	12
North Kaap Alluvial	1,866	19	16
Total	69,661	4	12

* *N.B.*—These five Companies are situated in Swaziland, outside the Transvaal territory, and are therefore not included in the output of De Kaap district, given in Appendix XXV. as 63,125 oz. The total output of these five Swaziland Companies, in 1892, was 6,536 oz., which added to the actual De Kaap output agrees with the total of 69,661 oz., as given by Messrs. Chesterton and Steeds in the above Table.

(*See* '*Fourth Annual* (1892) *Report of the Witwatersrand Chamber of Mines*,' *p.* 115.)

APPENDIX XXXIII.

Comparative Density of Population in South Africa in 1892.

Colony or State.	Population.			Area in Square Miles.	Density of Population.
	White.	Coloured.	Total.		
Cape Colony . . .	380,000	1,200,000	1,580,000	221,311	7·2
Natal	43,000	530,000	573,000	20,461	28·1
Orange Free State .	80,000	135,000	215,000	48,326	4·4
Transvaal . . .	150,000	650,000	800,000	113,642	6·5
British Bechuanaland	5,000	55,000	60,000	60,777	1·0
British Mashonaland .	2,500	250,000	252,500	150,000	1·7
Basutoland . . .	600	220,000	220,600	10,293	22·0
Zululand	600	145,000	145,600	8,900	16·3
Swaziland	500	63,000	63,500	8,000	8·0
Pondoland	100	200,000	200,100	3,869	51·5
South Africa . . .	662,300	3,448,000	4,110,300	645,579	6·4
England	27,560,000	..	27,560,000	51,000	540

The above Table comprises only about *half* of the regions south of the 18th degree of latitude. It refers merely to those portions of South Africa which are either already in possession of the white man, or proved to be suitable for European colonisation. It does not include the large territories of the German Protectorate on the West Coast, nor the British Protectorate of Bechuanaland, nor the Portuguese possessions on the East Coast. The population of the Cape Colony, Natal, Bechuanaland, and Basutoland, is based on the Census of 1891, and that of the Free State and the Transvaal on the Census of 1890. It is difficult to obtain trustworthy figures of the native populations, and these can only be regarded as approximate. Compare Table in Mr. Noble's 'Handbook of the Cape and South Africa,' 1893 ed., p. 568.

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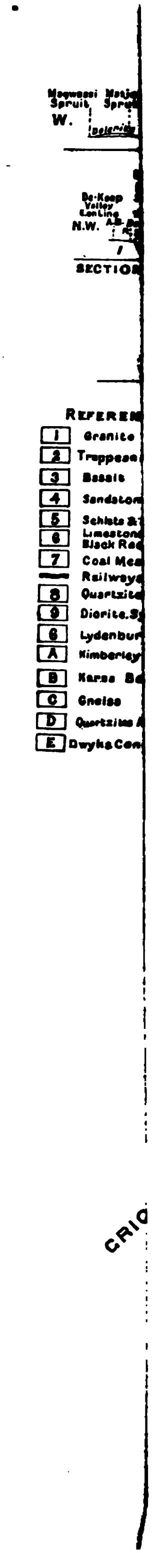

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